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THE AMERICAN GEOGRAPHICAL SOCIETY

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EARLY RELATIONS OF MAN TO PLANTS

CARL O. SAUER

MAN "evolved with his food plants," forming "a biological complex in which mankind and their food plants developed *pari passu*." "Our staple crop plants are heliophiles, sunlovers"; from them, in the course of time, "man developed agriculture in a sun-bathed environment." These are basic themes of a study that deserves to be familiar to all students of cultural origins and processes.[1] In that long, dim period before the dawn of agriculture are to be sought symbiotic systems and shifts of which early man was a part and which prepared the way slowly for his advance beyond collecting and hunting. The present essay is concerned with the primordial aspects of human time and culture as related to the vegetation with which early man lived, long before planting was thought of.

Ice Age: Age of Man

That the Age of Early Man and the Ice Age were approximately coincident has been well established.[2] *Homo sapiens,* i.e. physically modern man, has been determined as having lived during the Second Interglacial in England (Swanscombe man of the Thames basin, and probably also Galley Hill man) and therefore antedates any known Neanderthal man. The latter seems to have lost his status as a separate species and to have been only an aberrant variety or race, which interbred on occasion with Neoanthropic man, or *Homo sapiens* in the narrower sense. The more primitive Peking

[1] Oakes Ames: Economic Annuals and Human Cultures, Botanical Museum, Harvard University, Cambridge, Mass., 1939; references on pp. 11, 23, and 8 respectively.

[2] See the synthesis and critique of data on fossil man by W. E. Le Gros Clark in the March, 1945, and March, 1946, issues of *Antiquity* (pp. 1–5 and 9–12 respectively) and the masterly analysis of the records of human evolution in the light of genetics by T. Dobzhansky in the September, 1944, *American Journal of Physical Anthropology* (pp. 251–265). Frederick E. Zeuner's "Dating the Past: An Introduction to Geochronology," London, 1946, was seen too late to be used fully in the present paper; it is a remarkable comparative chronology of prehistory, the value of which does not depend on the acceptance of his absolute chronology of the Ice Age.

man is now assigned to the First Interglacial, and he has been linked closely with Java man, who seems to have been present in the First Glacial stage. Modjokerto man, also linked to Java man, has been placed in the lowermost Pleistocene of Java. And now Weidenreich, who started much of this overhauling of the human family tree, has found giant hominids that lived well before the beginning of the Ice Age.

The curious taxonomic labels, such as Pithecanthropus and Sinanthropus, that have been attached to different finds of fossil man are dropped in the newer biosystematics, in which human evolution has lost the peculiar mysteries that formerly kept *Homo sapiens* isolated from assorted "hominids" and reserved his appearance until almost the end of the Ice Age. The physical history of man is thus falling into line with the rest of organic evolution. It is now indicated that Java and Peking man (both now called *Homo erectus*) are on the same trunk that gave rise to the men of Swanscombe and Krapina, later to those of Cro-Magnon and Grimaldi, and finally to ourselves. An occasional branch died out without issue, as may have been true of some of the later Neanderthal folk, but the general phylogenetic picture now is of successive modifications of one continuous biologic entity. Most biologists would probably agree with Zeuner[3] that all fossil and recent men are "hardly more than 'good subspecies.'"

Since modern man is in direct line of descent from the remoter fossil races of man, the latter no longer have the limited interest of collateral branches, but, and this is of greatest importance, the cultural records of the Pleistocene represent the earliest and basic steps in all human learning. In shedding the vestiges of special human creation, we are forced to admit that the older archeologic artifacts mark the earlier human skills from which later developments of human art have stemmed.

That the Ice Age comprised or exceeded a million years is still our best estimate. Lately Zeuner has given support and currency to the astronomical-mathematical calculations of Milankovitch, which reduce the Pleistocene epoch to little more than six hundred thousand years.[4] The Milankovitch chronology agrees closely with other estimates of the last part of Pleistocene time (Wisconsin, Würm) but compresses the earlier part and reduces the length of the interglacial stages.

Rather than from astronomical theory, it would seem that better knowledge of the length of glacial time will continue to come from more and

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[3] *Op. cit.*, p. 295, footnote 1.

[4] F. E. Zeuner: The Pleistocene Period (Ray Society, Vol. 130, for 1942 and 1943), London, 1945.

better data of the sorts we have been accumulating by observation; namely from the comparative study of glacial and nonglacial deposition during the Pleistocene, from the degree of alteration of Pleistocene deposits by weathering and removal by erosion, from their radioactivity, from the rates of growth and wastage of ice sheets, and from the rates of origin and extinction of species of organisms.

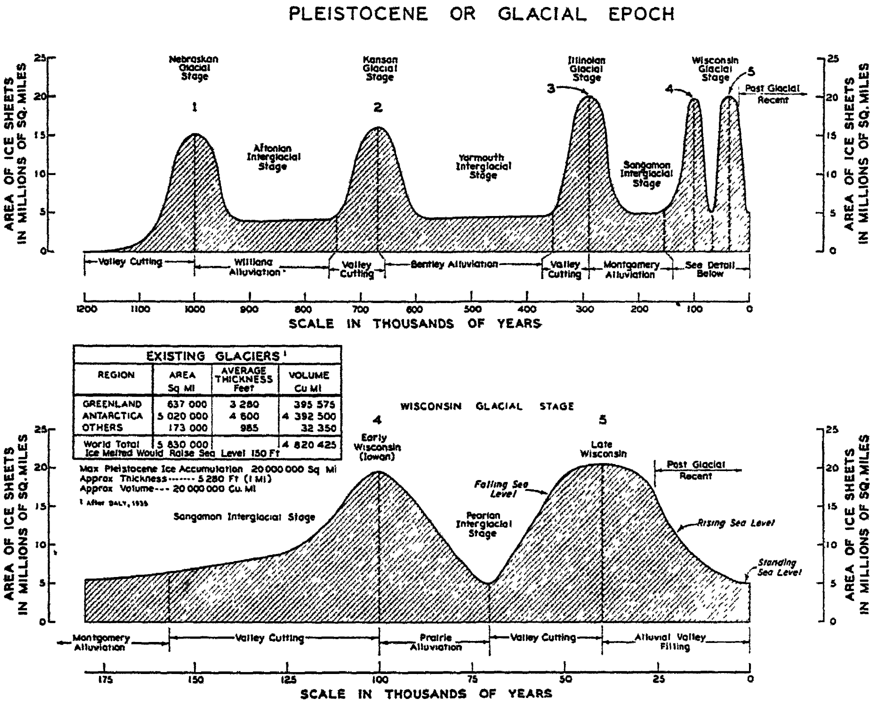

FIG. 1—Pleistocene time. (Reproduced by authority of the Mississippi River Commission.)

Knowledge of the length of the subdivisions of Pleistocene time and of the placement of human remains within them will be enlarged especially as marine terraces and stream terraces dependent on them are correlated with world-wide changes of sea level. We may learn much from terraces for which the eustatic position can be determined; that is, those which were formed by successive fall and rise of sea level, due to advance and recession of continental ice sheets.[5] The latest diagram of Pleistocene time and its stages is reproduced herewith (Fig. 1).[6]

[5] An excellent presentation is to be found in Zeuner, The Pleistocene Period.

[6] H. N. Fisk: Geological Investigation of the Alluvial Valley of the Lower Mississippi River, conducted for the Mississippi River Commission, U. S. War Dept., Corps of Engineers, 1944, Fig. 75. (Reviewed in this number of the *Geographical Review*.)

However fragmentary our present data, they are cumulative data and not theories of time. However inexact, the estimate that man originated more or less a million years, or almost forty thousand generations, ago is a starting point for considering what he has become and done.

Inferences from the Culture of Peking Man

The earliest generally accepted cultural record is that of Peking man, which is well advanced from that of a general *Urkultur*.[7] Before his appearance possibly a fourth of human time had elapsed, under the view of continuous human evolution as against that of collateral hominids. He had learned to live under a high-latitude climate of long winters, during which the requirements of food must often have exceeded the means of procuring it. Habitat and cultural remains alike show that we are not dealing with improvident half-apes but with men who were applying thought and forethought to living in a fairly exacting environment. Fire was basic to their culture.[8] They cooked food, which means that experimentation was under way in making not only animal but vegetable products palatable for human consumption. Woman was already about her business of developing specialized domestic activities. The presence of hearths shows that these folk lived with some degree of permanence at particular places. The number of hearths suggests that they may have lived in family groups, each accustomed to collect at its own place (hearth = home). There is nothing in this picture to indicate aimless wanderers, the mythical man pack or horde, drifting freely.

If man, from such an early time, lived in family groups, which met at the family fire, forming together a sort of primitive community that stayed put as long as seasonal changes in food supply permitted, it is also likely that each group held a more or less well defined territory recognized as its own by other groups.

Of plant foods the use of hackberry fruits only has been determined, but we may be sure that these people drew on all the plant food that they knew how to prepare.

Seven-tenths of the animal remains recovered are, it is reported, of deer. Are we to explain this dependence on deer for meat, bones, and skins as indicating the possession of effective missiles that would strike down this fleetest and most elusive game, or of snares or traps that would seize and

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[7] It must be noted, however, that the Red Crag flint "eoliths" of East Anglia, under controversy for half a century, are currently of good repute and that they now are assigned to the First Glaciation and hence are older than the Peking record (Zeuner, Dating the Past).

[8] As it appears also to have been for the earlier Red Crag folk.

hold it? In either case a technical advance is required that seems excessive for so early a time. Neither club, lance, spear, nor ax is a good deer-hunting weapon, and these were at best the arms at the disposal of primordial man. Peking men came into bodily contact with deer only if these had been maneuvered into positions from which they could not escape. In a desert area they might be taken at water holes, but in North China (for which there are no indications of aridity at that time) their habits would hardly have provided so easy a means of capture.

The question arises therefore whether the tool which early man managed best, namely fire, was not also the device by which he drove this fleet and timid game to destruction at his hands. Man, who had learned how to warm himself in cold weather and how to prepare his food with fire, perhaps directed his curiosity to the utilization of fire in other ways, such as hardening and pointing wooden tools and driving game.

The glimpse into a remote past afforded by the Peking finds is sufficient for us to ascribe to man an ancient role in the modification of vegetation. He had habitual campsites; he wore paths out from them that became bordered by trailside weeds that took advantage of the added sunlight and tolerated tramping and other disturbance. Seeds and roots were dropped along the trails and at the camps, and some of them grew and reproduced themselves. Kitchen refuse, thrown out about the camps, enriched the soil with ashes and nitrogenous matter, and new combinations of plants found advantage in the altered soil. Collecting grounds were disturbed by the digging for food, from roots and grubs to rodents. Dug ground is always open to vegetation changes. If fires were set primordially, at first to facilitate collecting and then as a hunting device, a most potent aid to vegetative modification was assured. Burning clears the ground of litter and makes easier the gathering of fallen nuts, acorns, and the like; it suffocates small, slow animals. It was the best simple device for driving fleet and big game so that it could be destroyed in mass. Wherever it was used, it affected the reproduction of plants and altered the composition of the vegetation.

These are preliminary examples of ways by which ancient collectors and hunters brought about changes in vegetation. If the activity of man in any of these directions was sporadic, no permanent alteration of plant complexes might result; but if activity was maintained in the same direction, cumulative, and possibly permanent, effects were registered in the association and perhaps the evolution of plants.

A major question therefore is whether areas, when once they had been occupied, remained under continuous human occupation. A subsidiary ques-

tion is whether they were subjected to increasing exploitation by larger numbers of men and developing cultures. Both will be considered below.

Development of Old World Cultures

Until after the beginning of the last glaciation, somewhat more than a hundred thousand years ago, change and divergence in human arts proceeded very slowly, judging by archeologic remains. In Europe, the Acheulian culture extended from the early part of the Second Interglacial to the end of the Third Glacial (Riss), some three hundred thousand years. Its stone tools, such as "hand axes," were shaped from cobbles or other suitable rocks, by striking off pieces until a core of desired form and edge was fashioned. Levalloisian tools were obtained by shaping flakes struck from a previously prepared core. Levalloisian remains have been found in Europe from the beginning of the Third Glacial to the middle of the last, a span of perhaps two hundred thousand years. The two cultures were contemporaneous for about half of their duration. Each shows certain development in technique, but it is apparent in both that skills and modes of life changed very slowly over very long periods.[9]

Perhaps this record of unprogressiveness is somewhat exaggerated. The meagerness of the data may be an accident of discovery or recognition. Also, an interpretation based on stone items alone is misleading; for some, or possibly many, groups may have directed their attention to working with plant and animal materials rather than with stone. It has been repeatedly suggested that cultures based mainly on wood and fiber may have been earlier than those based on stone. There are tribes still living, with a fairly rich culture, that work almost exclusively with plant and animal materials; the Bororo of Brazil are one well-known example.

Archeology perforce must deal with what it finds; for olden times the finds are almost wholly artifacts of stone or, more rarely, of bone. Archeological systems have therefore been elaborated mainly in terms of lithic industries. Stone lends itself especially well to the fashioning of arms for killing, blades for skinning and dismembering the kill, scrapers for preparing hides. Stone implements have therefore been largely interpreted as the equipment of hunters. Such gear has been preserved, the rest is lost, and thus a generalized but perhaps distorted picture of a succession of ancient hunters is construed.

On several counts it seems doubtful whether there were specialized hunt-

[9] Data from Zeuner, Dating the Past, especially pp. 282–295.

ing cultures in the Old World or anywhere else much before the relatively late date of the Solutrean folk, who penetrated only briefly into Europe. They were followed by the Magdalenian hunters, who seem to have come from Arctic lands. The generalized view for the farther reaches of human time should perhaps be rather that of variously differentiating cultures, depending on both collecting and hunting, some groups specializing more in plant raw materials, others showing more interest and proficiency in the chase, the direction of specialization dependent on comparative advantage of environment. The hunting peoples of historical time were strikingly limited environmentally in their distributions, in Arctic lands and on the great continental plains, and, so far as I can see, their predecessors (and possibly their ancestors) occupied in the main the same areas. There would seem therefore to be overemphasis on hunting in the interpretations of the habits of early man, and it is the purpose of this paper to take up the obscure record of his relations to his plant surroundings.

Many Paleolithic sites show evidences of sedentary occupants and long use and therefore may not be construed as campsites of folk concerned mainly with hunting. Most Paleolithic stone implements, usually described in terms of hunting use, have equal or greater utility for other purposes. The so-called "hand axes" would have been suicidally dangerous against any large animal and no more useful than a cobble against a small one; on the other hand, they could serve for cutting and splitting wood, for cutting bark, and in digging. The value of the ax as a weapon depends on the speed with which it can be swung and the ability to shift stance quickly; such a weapon appears after the Paleolithic in the small, polished celts. Scrapers, choppers, gravers, and various types of blades and knives served as well for the cutting and preparing of wood, bark, and bast, of roots and fruits, as for the dressing of meat and skins.

The culture of the Tasmanian aborigines is often cited in illustration of the survival into modern time of Paleolithic modes of life.[10] Their immigration, from somewhere in southern Asia, took place in the Ice Age. It is thought that they came most of the way afoot, crossing a narrow sea west of New Guinea on raft boats, and that the migration was effected mainly in a glacial stage of low sea level. They became isolated by rise of sea level and, being in a far corner of the world, retained in the main the Paleolithic traits that they had had at the time of their loss of contacts with the mainland. Sollas saw their stone culture as similar to conditions obtaining in

[10] This parallel, for instance, is well drawn by W. J. Sollas in his "Ancient Hunters," London, 1911.

southern Europe during the Riss-Würm interglacial, and its content does indeed indicate a separation from other people about then. Recently, the Keilor finds, near Melbourne, Australia, have strengthened such an inference. One of the skulls is said to have Tasmanoid qualities, and their stratigraphic position is assigned to this (Third) interglacial.[11] The interpretation is therefore that a peopling of Australia took place in the preceding (Third) glaciation, when Australia was accessible from Asia during periods of low sea level, and that these first colonists were progenitors of the Tasmanians.

The culture of the Tasmanians, then, is considered an authentic relic of the Middle Paleolithic, little changed because they remained isolated for a long time. They lived in a fairly attractive environment, and no theory of cultural losses need be set up. They changed little, not because they were miserable, or stupid, or slothful, but because they were cut off from contact with ideas from the outside world.

The few rude stone tools of the Tasmanians were used chiefly in cutting bark, scraping wood, notching tree trunks for climbing, and skinning animals. Their principal tools and weapons were of wood, such as digging sticks, spears, and clubs. Their most advanced art was the making of coiled baskets. They had no special devices for taking fish, but they did have raft boats, or balsas, made by lashing together rolls or strips of bark. As artisans they were more skillful in using plant materials than in working stone. It is of special interest that bark peeling was much practiced at this primitive level, and since the stripping of bark and bast is an effective method of killing trees, we thus have evidence of the early origin of another practice that resulted in alteration of vegetation.

The Australian aborigines became isolated from the Eurasian mainland at a later time than the Tasmanians. They had, for instance, products unknown to the Tasmanians: dart thrower, bark canoe, boomerang, bull-roarer, and shield. All of these were of wood: the Australian cultures also are poor in stone artifacts.[12] The dart thrower made its appearance in Europe in the Würm glaciation, and this may give a clue to the age of the Australian immigration. The main colonization of Australia by post-Tasmanoid peoples may have taken place during a stage of low sea level within the last glaciation (Würm), and contacts with the outside world were largely cut off thereafter by rise of sea level as continental ice melted.

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[11] Data from Zeuner, Dating the Past, pp. 279–280.

[12] The dog also got to Australia, but its earliest archeologic record in Eurasia is of Mesolithic time. It is known in Europe from the Maglemose (7000 B.C.?), and in Palestine from the Natufian, of somewhat older date. The question is therefore whether the dog was a later introduction into Australia, the isolation from the mainland having been not completely uninterrupted.

At least in the northern plains of the Eurasian continent, great hunting cultures arose during the last glaciation, principally the Solutrean and Magdalenian folk. These had projectile points of high power of penetration, finely edged blades, and a shooting weapon of precision and range, the dart thrower. Also, the Magdalenians had harpoons made of bone, perhaps developed in a sub-Arctic habitat.[13]

Mobile hunting and warrior peoples, the Solutreans and Magdalenians, quickly ranged with their new weapons over the plains of the Old World. The place and manner of their origin are a mystery; in Europe they appear clearly as invaders out of the east.[14]

With the fading of the continental ice, the pace of change was greatly accelerated on the Eurasiatic continent. It was no longer a matter of slow differentiation of collecting and hunting folk, such as had occupied the preceding 90 per cent of total human time. The final periods of the Ice Age were marked by a major revolution in the coming of Great Hunters, who dominated especially the wide continental plains. After them, but not derived from them, arose the Neolithic planters. The antithesis between mobile hunters and sessile planters is extreme. I know of no evidence that the former ever turned farmers, except late, and then reluctantly, under pressure. The attention of the hunters was diverted from plants; the origins of planting must be sought in cultures with strongly sedentary qualities and major concern with the exploitation of plants.

New World Developments

On the basic early cultures of the New World, their changes, and how they are related to those of the Old World we are still mainly uninformed, in part because authority took a dogmatic position against the presence of man in the New World during the Ice Age and has maintained its censorship—even now only partly relaxed—for many years. The circumlocution "Paleo-Indian" is still used in describing the older inhabitants of the New World, and "Paleolithic" tacitly is not good usage in New World archeology.

There is no reason in what we know of the history of the Ice Age and of the evolution and spread of mankind for excluding man from the New

[13] I know of no good evidence of the bow and arrow before Mesolithic time. Feathered shafts, as depicted in pre-Magdalenian cave drawings of wounded big game, do not prove the presence of the bow. Feathered shafts are equally characteristic of the dart thrower.

[14] Zeuner (Dating the Past) has reassembled the data on the age of Upper Paleolithic cultures. He places the Solutrean as about 70,000 years ago, the remainder of time in the last glaciation as mostly occupied by the Magdalenian. The present trend in European archeology is therefore to make these great hunting cultures definitely Würm in time, a revision to a markedly greater age than that previously attributed to them.

World until the final stage of glaciation, as is the present vogue. North America was not significantly more difficult to reach from the ancestral hearths of man than Australia or transdesert Africa. Siberia and Alaska were never generally blanketed by icecaps. North America was probably inaccessible during the interglacial stages of high sea levels, but not when the levels were low during glaciations. Peking man solved at an early date the problems of survival through northern winters. It need not have taken his successors a long time to learn how to live on coasts of still higher latitudes. In view of the known expansion of man elsewhere in the Old World, it would be surprising if the margins of the Okhotsk and Bering Seas should prove to have been uninhabited during the Second Interglacial, or perhaps even earlier. After the great Second Interglacial, in the Third Glaciation (Illinoian), when sea levels dropped considerably, a colonization of the New World is not at all improbable. By that time, it appears, Australia was inhabited. Farthest Africa and the British Isles were occupied long before then. Why should a feasible corridor into the New World alone have remained unused?

The fact that no skeletons more primitive than primitive forms of *Homo sapiens* have so far been recovered in our hemisphere has ceased to be an objection to man's antiquity on this side of the ocean, since Swanscombe, Galley Hill, Keilor, and other finds have established *Homo sapiens* in wide dispersal far back into the Ice Age.

Ethnologically, the case for a similarly early detachment of the Yahgan of Tierra del Fuego and the Tasmanians from a common trunk of cultural evolution has often been urged by diffusionists. The alternative to considering such very backward peoples, including primitive rests in the forests of the Guianas, of the South Pacific coasts, the collectors of the Brazilian highlands, the Guaycuru and Pericu of Lower California, the Yuki of Upper California, and the Beothuk of Newfoundland, as relics of cultures derived from the Old World well back in Paleolithic time requires alternative hypotheses of quite unlikely losses of useful skills. The cooking habits of simple tribes of the Brazilian interior,[15] who get along without any boiling, find no explanation in their environment, but rather in old cultural habits. Long in contact with pottery-making peoples, they make casual or no use of pots but restrict their cooking to roasting and baking; gourds, a late acquisition, are used for carrying water. The absence of the dog among

[15] Curt Nimuendajú: The Eastern Timbira, translated and edited by R. H. Lowie, *Univ. of California Publs. in Amer. Archaeol. and Ethnol.*, Vol. 41, 1946.

many more primitive or archaic tribes in America, especially South America, suggests that these folk immigrated before the dog was domesticated.

Such straws of culture traits are numerous and point to ancient arrivals from the Old World of certain groups, who have remained extremely conservative in the New by reason of having survived in isolated pockets. They are intelligible if acknowledged as links to the Old World Paleolithic of the later Ice Age, and it seems to me only so.

Items which impress me as having been introduced into the New World during the Ice Age (though not all at one time) and which continued to be in use here and there into historical time include the following: fire (hearth, fire striking, fire drill, roasting and baking, stone boiling, hardening and pointing of tools, fire drive), barkpeeling (household vessels, one-piece bark canoes, sewed bark canoes), woodworking (digging stick, lance, dart thrower, paddle, bull-roarer), fiber working and the like (cord twisting, coiled baskets, snares, nets, tied matting, balsas), boneworking (awls, drills), stoneworking (percussion flaking, choppers, scrapers, blades, some points, grinding stones).

The older archeology of the New World is still mainly a lot of unassembled bits of knowledge. Important is the growing realization that preceramic remains stem from a very long period of time and that types of artifacts in many cases are really diagnostic of their age. The known sites are predominantly in our arid and semiarid areas, partly because there happened to be alert archeologists at work in the Southwest and partly because both preservation and inspection are aided by low rainfall. It is quite possible that a period of research and synthesis is beginning there which may make that area such a key to the American Paleolithic as France was for the Old World. The following remarks are set down in the spirit of giving aid to such hopeful inquiry.

The determination of the age of early vestiges of human occupation is broadly a geomorphologic problem.[16] Along the southern peripheries of the areas covered by the continental ice sheets direct relations of man to glacial deposition may be ascertained. Mostly, however, the sites lie, and will continue to be found, in areas untouched by glacial or fluvioglacial and loessial deposits. Equatorward displacements of storm belts resulted in pluvial periods over areas now arid. At such times rain water percolated through the roofs of caves and deep rock shelters and formed dripstone or travertine on their floors, thus sealing off the remains of earlier human occupation. In pluvial periods undrained basins held fresh-water lakes and

[16] For a comprehensive presentation of the subject see Zeuner, The Pleistocene Period.

marshes, on the edges of which people lived in areas later unavailable for lasting settlement. Were the pluvial conditions, widely recorded in southwestern and northern Mexico, coincident with Wisconsin glaciation?

Perhaps the greatest prospect of the discovery of early sites, however, lies in the association of human settlement with marine terraces, continued landward as stream terraces. Across Texas, and again in Sonora and Lower and Upper California, series of primitive artifacts are found in characteristic positions upon and also within terrace fills. These terraces may be, in whole or in part, eustatic and hence record the chronology of the Ice Age. If their synchronization with world stages of glaciation and deglaciation can be established, a sufficiently precise determination of the ages of their human remains is achieved. Their patterns of sedimentation, continuity of surfaces, weathering, and erosion are so persistent that their deciphering is one of the most promising tasks ahead of geomorphologic science.

In all interpretations of how men fashioned their different ways of living in the New World the length of their presence here and the number and order of their immigrations from the Old World are vexing unknown factors. The length of human presence in America is also involved in problems of our plant geography and evolution. It makes a good deal of difference whether men have been in the New World fifteen or twenty-five thousand years or much longer, say perhaps ten times as long as that, or a fourth of all human time.

The best immediate prospects for finding out are in Texas and Lower California. In Texas, it may be hoped, the interest of a number of workers in stream terraces and their relations to sea levels will give results before long that may unlock the chronology of the New World as the studies of the Somme terraces did that of the Old. We made a reconnaissance of Lower California from the University of California in the summer of 1946 and found there a promising situation to investigate. Peninsular California has persistent and consistent marine terraces in number, with an abundance of archeologic material upon, and apparently also within, them. There is good evidence that pluvial conditions, and human occupation, prevailed across the whole of the Lower California desert. Further, there are many undisturbed caves and rock shelters which were occupied by man and which have preserved plant materials and objects fashioned from them. Even our first inspection gave strong indications that human remains and their sites do not fit into the compressed time scale at present applied to man in the New World.

The assortment of available data suggests a number of ancient cultures

that may have been introduced or have originated in the following order:

1. The most primitive and ancient of these may have lacked both stone points and grinding stones. I am not aware that stratigraphic or geomorphologic proof has been found, but the category seems to be necessary. These implements are lacking among numerous historical peoples in both South and North America, without environmental reason.

Seed grinding and its artifacts, for instance, are of especially restricted distribution in South America, whereas they are, or were, widespread in southern and western North America under similar conditions of food collecting. Away from the Caribbean coastlands archeologic records of grinding stones in South America are few, mainly Andean, and appear neither to be early nor to have formed anywhere a dominant device in food preparation (except for the quite distinct manioc graters). The inference is that many South American peoples derived their culture from a substratum lacking food-grinding habits and that their arts of preparing food developed along other lines. The hafting of stone points to projectile shafts also is a trait that numerous people never adopted, especially to the south of the United States.

It may be expected that some of the very primitive archeologic sites, such as have been reported from Texas and Argentina, which yield only rudely percussion-shaped tools, without points, will prove to be really the oldest. That the age of a complex of artifacts may be read by the skill and specialization they exhibit is perhaps correct where sites of minimal skill occur with more advanced ones in the same area: folk of low skill are unlikely to displace cleverer ones. In particular the sites of rudest art are to be regarded as the oldest if they mark habitats physiographically and climatically least suited to present occupation. The earliest cultures are most easily overlooked, because their products are least readily recognized as fashioned by human hands, because their sites are likely to be small and slight, and because these sites are likely to be in places where one is not accustomed to look for human habitation. Their search and study have scarcely begun.

2. The ancient food grinders are known from Texas to California, and also in Sonora and Lower California. The generalized association is the building of hearths on a bed of collected stones, the use of a grinding or mealing slab on which a handstone (*mano*) was rubbed back and forth or in an elliptical or circular motion, and an assortment of rough percussion tools, mostly choppers and scrapers, which may have been made by the same

technique as the Old World Levalloisian. Rude knives are present, but projectile points normally are wanting.

An early seed-grinding culture was first described by D. B. Rogers as that of the Oak Grove people of Santa Barbara County in California. Their knolltop sites are recognized and characterized by the abundance of handstones and slabs and the absence of almost all fishing and hunting remains. Rogers' excellent pioneer work unfortunately was published before there was real recognition of the problem of early man in this country, and it has never received the attention it deserves.[17]

In the southern basin plains (Cochise) and in the Papago desert (the Ventana rock shelter) of Arizona, Haury and Sayles have found evidences of collecting and grinding cultures in the basal horizons of sites of long-continued or repeated occupation. Their work has placed the earliness of such cultures beyond all doubt in the arid Southwest. The early grinding folk lived under a pluvial climate markedly different from the present, and the important and unsolved question is how long ago a humid climate existed in our arid Southwest. In Sonora, I saw in the spring of 1946, in company with Haury, a series of sites typologically similar to early Cochise, extending well south of the Mayo River, and characteristically in situations that are disadvantageous for access to water or food under contemporary conditions. In Lower California, later in the summer, a party from the University of California found many similar situations.

Early food-grinding settlements, therefore, were spread over wide areas between the Mississippi Valley and the Pacific coast. From most, if not all, of this region the mano and grinding slab subsequently disappeared, in places abruptly, and were never reintroduced, or reappeared only long after in the form of the metate, when corn growing was brought in from the south. I have seen a good many sites of such early grinding folk, in California, Lower California, Sonora, and Arizona, and as a rule they are not properly situated now for victualing or watering a population; they do not make sense in terms of the present topography and vegetation, and this, I take it, is a good indication that they were occupied long ago.

This innovation in food preparation is not to be explained as a device for aid in cooking starchy roots, plant stalks and leaves, or fleshy fruits. These had been, and continued to be, prepared simply by roasting on coals and in ashes or by baking in pits. Even now, agave shoots, wild yams and

[17] D. B. Rogers: Prehistoric Man of the Santa Barbara Coast, Santa Barbara Museum of Natural History, Santa Barbara, Calif., 1929.

potatoes, and other tubers and bulbs are not processed by grinding in Indian cooking. The new process made possible the utilization, or larger use, of hard seeds and small ones, such as those of grasses, of *Chenopodium* and amaranths and their relatives, of various Compositae, such as sunflowers, tarweeds, and ragweeds. It also was applicable to the preparation of bitter, starchy fruits, such as acorns, and starchy roots with noxious qualities, such as various aroids, which could not be made edible by cooking the entire tuber or root. Some of these were palatable when merely cooked after the grinding; others needed the additional step of leaching. The introduction of grinding brought a long-continued series of additions to the primitive kitchen resources.

The process yielded meal, which, mixed with water, was baked in cakes, or cooked as gruel, or put into stews. Food grinding thus presupposes the presence of receptacles for holding water and of others for the ground meal and could hardly have been developed until after the possession of good, almost watertight vessels. The region of major distribution of early food grinding is poor in trees yielding suitable bark for vessels but rich in useful fiber plants. That well-woven baskets preceded the grinding slabs seems to be a proper inference. The collecting of small seeds also involved seed beaters, collecting and carrying baskets, and winnowing.

It may not be coincidence that the general region through which the sites of early food grinders are spread is also one of the major regions of the world for the occurrence of coiled basketry, both historically and archeologically. Students of diffusion have pointed out the high antiquity of the coiling technique, by no means an obvious device for fashioning a receptacle.

The food-grinding folk were inclined to sedentary ways, and they are readily located by the quantity of remains they left behind through continued occupation of one spot. The Old World offers little that is parallel to this important development, though in simple and rather casual form it is found in Australia. In rudimentary form it may have come originally from Southeast Asia, but in the major development it looks as though this mode of food preparation was an achievement of the American Southwest and its borderlands.

3. Another series of sites shows increased preoccupation with hunting and the introduction of developing series of stone projectile points. With these folk there was still permanence of habitation, shown by hearths and accumulations of artifacts, and also by the presence of seed-grinding stones.

I had the opportunity in the spring of 1946 to visit the area around

Abilene, Tex., under the guidance of its acute local student, Dr. Cyrus N. Ray.[18] Although not involving the earliest sites of man in Texas, this area may be critical for part of the history of Ice Age man. Ray has identified seven consecutive horizons, of wide distribution in the valley fill on the affluents of the Brazos River. All but the first horizon are deposits laid down in slack or slowly moving water. The lowest horizon (Lower Clear Fork) is of greatest interest, for the hearths and artifacts it bears *in situ,* as well as for bones of extinct large mammals. The occupants of this earliest level were both food grinders and hunters. Several kinds of primitive points have been found at this level, which impressed me as having been an old land surface probably exposed and occupied by man for a considerable length of time. This basal surface was later buried by gentle and long-continued flooding. Several of the overlying sedimentary horizons show a varying degree of soil development, with hearths and artifacts. Until adequate field and laboratory study reveals the succession of events recorded in these deposits and their weathered surfaces, the interim conjecture may be ventured that the Lower Clear Fork surface was the surface of land at the time of the last Wisconsin maximum and that as continental deglaciation got under way and ocean levels rose, widespread silting of valleys took place. In that case the interludes during which weathering profiles developed registered halts in the process of world-wide deglaciation and need not indicate any local changes in climate. Thus the Lower Clear Fork may have been a surface of human occupation about thirty-five thousand years ago, when men were experimenting with projectile points of stone. It may even be that some of these were precursors of so specialized a development as the Folsom craft and that one need not look to an Old World derivation of the latter.

The early use of medium-sized stone points raises the question of the age of introduction of the dart or spear thrower (also called *atlatl* after Mexican usage, or *estolica* in South America). That it originated in the Old World is inferred from its use among Australian tribes who are bearers of a culture only slightly less primordial than that of the Tasmanians. This apparently oldest of all known devices for manual propulsion of projectiles is so ingenious that it is probably an invention, made once, and then widely and early diffused. There is growing and reasonable inclination to regard stone points of intermediate size (and it is these that appear earliest) as having

[18] See his critical summary of archeologic-geomorphologic conditions, with stratigraphic profiles, "Stream Bank Silts of the Abilene Region," *Bull. Texas Archeol. and Paleontol. Soc.*, Vol. 16, 1944–1945, pp. 117–147.

been used with dart throwers.[19] The advantage of the dart thrower over the spear and the javelin lay in its speed and precision, due to the flattened trajectory. It required a light shaft and would not bear a heavy point.

4. After a time there were mobile hunting folk, who paid no attention to food grinding. In places, as about Santa Barbara, there is an abrupt break between the two kinds of habitation (even a change in physical type), suggesting that the hunting people may have rudely displaced the earlier people. The Folsom and Yuma cultures represent high specialization in big-game hunting. Their interest in plant food and fibers was probably minimal.

5. A good while after the disappearance of continental ice sheets we get the first records of the bow and arrow, the dog, fishhooks, and polished stone. All of these, it would seem, were introduced by later comers from the Old World and appear to be the prelude to full Neolithic conditions and agriculture. They fall therefore after the times considered here.

Summary of Early Culture Sequences

This sketch has attempted to outline the salient features of cultural diversification of all but the last 2 per cent of human time, covering nearly the whole of the Ice Age. There is no certain record of humans before they knew the use of fire. As master of fire, man had security at night from predators; he was able to move into cold climates; he had hearths, about which the life of the family centered; his women began the endless experimental chemistry of food preparation; he learned to shape tools by hardening and charring wood in fire; he learned to use its pitiless force in driving and overwhelming animals, great and small. Knowledge of the stripping of bark and bast for the fashioning of vessels and cordage taught him an easy way to kill trees and thus provide himself with a convenient supply of firewood. The fashioning of cords into nets and of fiber and withes into coiled baskets provided early kitchen and carrying vessels. In working with stone he developed, with slowly growing skill, a series of simple tools that receive most of the attention of archeology, because they almost alone have been preserved.

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[19] A. D. Krieger (Some Suggestions on Archaeological Terms, *Bull. Texas Archeol. and Paleontol. Soc.*, Vol. 16, 1944–1945, pp. 41–51) observes: "There is . . . a very decided chronological distinction between 'bird points' and the heavier dart points. The true arrow points with their light construction definitely appear at a relatively late time in all sections of the country. In Texas, as well as to the west, south, and east, arrow points appear in the latest horizons, along with agriculture and pottery making. . . . Dart points, on the other hand, are very numerous in the cultures which precede" (pp. 49–50). North of central Mexico the dart thrower disappeared before historical time.

Until the final stages of the Ice Age men lived, wherever they were, by both collecting and hunting, gradually diverging into differing cultures. Toward the end of the Ice Age tempo and mood of cultural evolution (divergence) changed sharply. Especially in the New World it appears that a new age began with a basic improvement in sustenance through the introduction of food grinding. Another revolutionary impulse came with a precision weapon, the dart thrower. At the very last appeared the roving big-game hunters, owning a skill in fashioning blades and knives that has never been surpassed in stone. In terms of our present information it seems that more cultural advance and divergence took place from the middle of the last glaciation (Wisconsin, Würm) to the beginning of Recent time than in all the time between the days of Peking man and mid-Wisconsin. Also, I would suggest, the evidence is beginning to indicate that the New World may have participated equally with the Old in the cultural advances of the later Ice Age.

Population Growth

An implication of this summary of the early human record is that successive waves of migrant peoples as well as of inventions spread outward from the ancestral hearths of man, considered as lying in southern Asia. Such pressures began early and were long continued. We need next to consider the nature of their transmission and some of their effects.

As to the manner of peopling of the earth, these main generalizations are put forth: that man has been from his primordial days a vigorous colonizer; that there have been repeated times of strong population increase; and that man's expansion over most of the world was not the result of nomadic habits.

Population growth, both for man and for other organisms, is controlled by available food. The famous sinusoidal curve of population climbs rapidly to a plateau at which it levels off, when number of consumers has grown to the full use of the food supply. The history of human population is a succession of higher and higher levels, each rise to a new level being brought about by discovery of more food, either through occupation of new territory or through increase in food-producing skill. The act of expansion into new habitats also stimulated food experimentation with new sources, and frontiers of settlement therefore were likely to generate a sustained growth potential and expansiveness. A group colonizing a new terrain had at first at its disposal only those resources that were familiar from its previous habitat. It had also the opportunity or urgency to try out unfamiliar substances, some of which

then became new resources through successful experimentation. Thereafter population checks became increasingly operative unless more new land was taken or new skills discovered additional resources. The term "resource" implies the determination that the thing is useful, and therefore a cultural achievement.

A new colony might increase to the limits of its sustenance in one generation; it would usually do so in several. Thereafter its population must level off, either by the gradual convergence of birth and death rates or by draining off the surplus to daughter colonies. In early human times the frontier of settlement advanced rapidly along seacoasts, where food collecting was easy and profitable and the problems of changing habitat were at the minimum. Valleys of moderate size, in diversified terrain, also were easily penetrable and rewarding. Frontier communities were always in the most advantageous position for expansion by hiving. As the edge of settlement moved farther and farther ahead of a given community, the latter had less and less opportunity to contribute to the moving frontier. Poorer opportunities may have remained in seeking out near-by tracts that were less inviting. In time there ceased to be new land to occupy, and perhaps also new modes of making use of the land, and then growth ceased. In manner any peopling of the earth at any time must have resembled the modern filling in of the frontier in America: vigorous and rapid flow into the areas of greatest attraction; slow seepage into areas of indifferent return; stagnation in more and more areas of older occupance.

Density of population of collecting and hunting peoples may not be estimated from their modern survivors, now restricted to the most meager regions of the earth, such as the interior of Australia, our Great Basin, and Arctic tundra and taiga. The areas of early occupance were areas abounding in food, where densities of one or several inhabitants to a square mile could be supported by simple skills. In such areas, such densities should have been reached within a few generations of their original settlement. Collecting man, omnivorous in habit, having the curiosity to experiment with all the plants and animals at hand and aided by fire in the preparation and preservation of food, must soon have become by far the most numerous of the larger mammals almost wherever he established himself.

Unless restrained by some belief, such as of totem, man set the limit on the number of carnivores he tolerated in his domain. The rest of creation lived in fear of him, not he of them. On his danger from fellow man we have diverse opinions, but war as a serious check on his numbers is the result of cultures advanced beyond those of early societies. Sustained and deadly

warfare presupposes sustained discipline over the individual by political authority. We get perhaps the first traces of this in the big-game hunters, who were also warlike. Bad seasons brought famines, and areas subject to serious climatic variability leveled off below the densities supportable in good years. Not much significance need be attached to pestilence in primitive settlements. They consisted of small groups, not strongly intercommunicating. Epidemic diseases are bred and spread through congestion of populations; they belong to much later times of human history. Rigorous selection was operative, but its results were vigorous stocks, who enjoyed usual good health and normally lived through their reproductive years, except for the hazard of accident.

For no early time is there indication of solitary habits or nomadic mobility. As far as we know, men always preferred to form communities and were as sedentary as their food supply permitted. We may judge that when skills were minimal the community usually was small. Except for rich collecting grounds on bays and estuaries, half a dozen, or at most a dozen, families could make full use of the food supply within convenient foraging distance. We may estimate that under ample environmental conditions an area about the size of our township (36 square miles) would be a full-sized unit of exploitation by such a group from a single living center. Man sensibly conserves his energy at daily and necessary tasks and does not impose upon himself exhausting distances in bringing in his supplies. A radius of 10 miles would be excessive for regular provisioning, since it would require most of the day en route. The center at which the habitations were placed was normally determined by water close by, by minimum effort and distance in assembling the constantly needed items of food and wood, by shelter against inclement weather, if available, and by easy convergence of trails. If the site provided all these desiderata throughout the year, it was occupied permanently; if not, camps were shifted seasonally. Man was not inclined to move about unnecessarily, and he had reason for nomadic habits only where he depended on a nomadic staple for sustenance, as in the hunting of herd animals, a late, not an early, development. Over the world, hearths and middens of high antiquity attest that man's ancient custom was to fix his habitation and not to diminish his comfort and well-being by wandering about. Many individual shell mounds, whether or not they indicate continuous occupance, record habitation at a given spot running through thousands of years.

If man had the sense to know a good campsite and to occupy it as long as it was less troublesome to live there than to move, the camp would also become the place for the storage of supplies, for the setting up of work-

shops, for social and political activities, for all the growing paraphernalia, so that increment of goods and contacts further attached people to such places.

Occasionally a new step in learning was achieved by some group, which raised its economic potential. The invention of a better tool, of a new food preparation, of better storage, expressed itself in the development of a new resource, in larger inventory, and in increase in population. Such progressive cultures, by making higher use of the land, were able to exert pressure against neighboring groups that had failed to share in the advance. The latter, increasingly at a disadvantage, evaded pressure from the stronger group by withdrawing into less desirable areas. Inferiority in competition and in numbers was in time sufficient for displacement or absorption of the weaker and more backward, whether violence was involved or not. Thus a succession of colonizations could continue with each significant advance in culture. The more progressive the group, the larger was the number that could be supported from a given area, the more numerous the associations possible in individual communities, and the stronger the sedentary habits.

If this view of the nature of population growth is correct, Paleolithic time, or the Ice Age together with some thousands of subsequent years, was a period during which men spread permanently into all parts of the world that were accessible, and this meant all the larger land masses not blocked by ice. The rate of increase was rapid wherever the food supply permitted. Further waves of population movement were set up outward from centers of cultural progress. Well-being, even survival, depended on practical skill in using the occupied habitat. Biologic population pressure was constantly building up and was eased then, as now, by advance in territory or in art. There was no place for irrational folk (prerational man), who failed to use their wits, who lived in illusions, who abandoned a good thing in their possession. There is no reason to think that primitive men drifted about through a wilderness, abandoning one home for another because of some obscure urge to wander. There is no reason to think that any area which satisfied human wants was ever depopulated or remained underpopulated. These primitives were superior, vigorous animals, gradually extending their mastery, not broken, dying remnants in confusion and despair in retreat positions such as have given rise to certain modern views of primitives. I should like these remarks of population growth and permanence of occupation to apply with equal force to the New World; whatever the time available, there was plenty to fill it to the limits of food-getting ability.

Modification of Vegetation

This résumé of what happened to ancient man carries implications as to what happened to vegetation during the Pleistocene. If man's spread over

the earth was early and enduring, the time and manner of his intervention in the plant world were sufficient to affect plant evolution. If primitive men became significantly numerous and, especially, if they were in continuous exploitation of their habitats, cumulative modifications of vegetation must have taken place. This is perhaps the most important conclusion to be drawn from the preceding pages. If men were casual habitants, who drifted on, their former range left vacated until another group accidentally wandered in, the effects of human occupance would soon be erased, like the marks of a storm or other natural catastrophe. If, on the other hand, human presence characteristically was continuous, any shift, however slight, brought about by man in reproductive advantage among the local plants must result in time in important changes in the plant population. The Ice Age, regarded as the time of world-wide expansion of the human race and of its increasing domination over flora and fauna, is also the time, as Professor Ames has said, in which the evolution of man and that of a good many plants became interdependent. The natural history of the Pleistocene, then, is important in evolution not only because it was a time of extraordinary climatic and orogenic stresses but because during this time man became more and more an agent of suppression and selection for other organisms.

For the earlier levels of human culture it is unnecessary to postulate purposeful change in vegetation at man's hands, yet he modified the plant complexes continually in directions that increased their utility to his economy, molded the nature of his economic habits in new directions according to new environmental opportunity, and perhaps, as Ames suggests, thereby influenced his own physical evolution. Toward the end of the period reviewed here, I suspect, he may have begun the first conscious steps in plant management. The chief acts by which he intervened in the plant world I take to have been these: (1) The campsite was the center of most intense disturbance. Here most of the vegetation was removed to make room for the communal living. The ground was subjected to continuous tramping and became packed. (2) Refuse accumulated about the camp, of shell, bone, plant materials, and ashes, which formed a soil heavily enriched in nitrogenous material, in lime, potash, and phosphate. (3) In forest, wood, and brushland adjacent to the community the useful woods, barks, and bast were depleted. Trees were thus killed, and the resulting fall of dead branches and trunks provided the common fuel supply. In time this process of deadening might extend to a notable distance from the permanent settlement. (4) Trails opened up strips of trodden ground, and along them accidental scattering of seeds and roots took place, by loss in transit. (5) Digging

for edible roots and bulbs kept such harvest grounds disturbed, mixed the soil, and gave opportunity for the multiplication of the pieces that had been missed. Root digging was, in fact, unplanned tillage. (6) Newly immigrated groups of men often brought along viable seeds by chance. (7) The setting of fires to aid collecting and hunting has been stressed previously as the most effective device in the alteration of vegetation. Its effectiveness depended on recurrent use, and thus on continued occupation of area. (8) In time the practice of protecting trees and shrubs that were prized may have become established; living primitives are still likely to do so, and advantageous behavior should not be denied to early people whose existence depended on acting intelligently within the range of their experience.

The ecologic effects included the introduction and establishment of species from other localities, but the most important results are to be found in the ways by which man placed certain plants under reproductive disadvantages and increased the opportunity for others. Thus plant associations became increasingly altered or reconstituted to the extent of the elimination of species from a given flora. Man's activities were directed especially strongly toward diminishing the shading of the ground. Every leafy tree or shrub that died and was not replaced by a similar one made room for the colonization of sun-loving herbs. Little by little, spaces were opened for heliophiles, and thus the first steps were taken that, as I have indicated elsewhere, may have resulted in the great grasslands of the hunting cultures.[20] Except for deserts and the permanently moist ground surface of rainy tropics, higher mountains, and higher latitudes, the vegetation of most parts of the earth bears in varying degree the impress of plant replacement by man, chiefly of fire succession. Thus plants, which before man were minor and localized elements in a flora, found steadily improved opportunities for increase.

Ames has pointed out the heliophile character of most of the cultivated plants. The exceptions are indeed minor, such as coffee and cacao. It is also true that the great majority of wild plants used by man as fruits or roots are sun-loving. By the gradual opening of sunlit spaces he unwittingly favored the multiplication of food for himself. Later he may have learned to do so deliberately. Whatever the climate and the terrain, even if it is marsh or pond, the plants of human food interest are usually found in the sunlit habitats of any area. Our fence rows, roadsides, old fields, and forest burns are populated by diverse berries, bush and tree fruits, and heavily seeding annuals. The wild plants that provided the Indians of the United States

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[20] C. O. Sauer: A Geographic Sketch of Early Man in America, *Geogr. Rev.*, Vol. 34, 1944, pp. 529–573.

with their staple seeds, roots, tubers, and bulbs were harvested mainly in woods margins and on prairies, or at the edges of sunlit streams, marshes, and ponds.[21] Before the time of man such plants had more restricted habitats, especially in nonarid climates. Stream and lake margins admitted sunlight to narrow strips of ground. Windfalls opened space briefly in woods. Cliffs, slumping slopes, caving banks, and fresh alluvial surfaces made niches for plants that could pioneer in open ground. With the advent of man increasing space was provided for heliophile herbs in many climates, but especially on ground that had some seasonal dryness and hence was most sensitive to effects of burning, deadening, or digging.

Additional ecologic changes should be noted: (1) Thinning of litter and leaf mold occurred, accompanied by somewhat increased runoff and decreased penetration of rainfall, and hence by some reduction in leaching, and possibly increase in *p*H value. A certain degree of shift from acidic to neutral soils is inferred.[22] (2) An advantage was furnished to aggressive, weedy plants, characterized by free seeding, broad tolerance in germination, and robust early growth. (3) A shift took place from long-generation to short-generation species, in particular increase in numbers of annuals, biennials, and plurennials. The Pleistocene is considered to have been the period in which very many annual species originated. It may be suggested that the disturbances produced by man may have been a major reason for the emergence of a host of new, annual species. Dug-over ground, trailsides, and village margins are still good places to encounter members of such families as Amaranthaceae, Chenopodiaceae, Solanaceae, and Cucurbitaceae, which have played and still play a notable role in the feeding of man. Also, of course, uncounted species of grasses and Compositae are thought to have originated within the time of man. (4) That frequency of disturbance of tuber-bearing plants is likely to encourage their reproduction anyone who has dug tuberous sunflowers, yams (*Dioscorea*), *Cyperus*, or *Dahlia* can attest. (5) Whenever protection was afforded to plants (trees) of one species, man was intervening to establish the dominance of that species in a given spot (formation of groves). (6) The refuse heaps furnished a specialized

[21] O. P. Medsger (Edible Wild Plants, New York, 1939) provides an instructive catalogue. From his list of edible roots and tubers I abstract the following: mainly in wet sites, arrowhead (*Sagittaria*), nut grass (*Cyperus esculentus*), calamus (*Acorus*), camass (*Quamasia, Camassia*), groundnut (*Apios tuberosa*), cattail (*Typha*), aroids (*Peltandra, Calla*); in prairies and woods margins, sego lily (*Calochortus*), bitter-root (*Lewisia rediviva*), prairie apple (*Psoralea esculenta*), hog peanut (*Amphicarpa*), cowas (*Lomatium geyeri*), yampa (*Carum gairdneri*), wild potato vine (*Ipomoea pandurata*), valerian (*Valeriana edulis*), Jerusalem artichoke (*Helianthus tuberosus*), wild potatoes (*Solanum fendleri* and *S. Jamesii*).

[22] The gradual replacement of heavy and deep-rooted trees and shrubs by fibrous-rooted herbs and grasses continued the shift.

habitat for plants grossly feeding on nitrogenous matter and the nutrient salts dissolved from ash, bone, and shell.

Thus, also, the processes of evolution were aided by man. Disturbances that he set up and kept up shifted survival chances in favor of an occasional variant plant. With more variants able to reproduce themselves, further diversity resulted in their offspring. (1) Gene mutations, affecting life cycle (for example, annual habit) or germination, which previously did not establish themselves under natural competition, might acquire reproductive advantage. (2) Polyploidy, especially if resulting in increase of size of seed or plant, quicker or more robust growth, might favor survival. (3) Introgressive hybridization was aided by accidental scattering of seed brought in from other localities. Unconscious human selection of plants was operative if any protection was given to any stand or clump because of the palatability of its fruits, seeds, or roots.

A new symbiosis between plants and men was therefore in progress. The greater the increase in human populations and the less their mobility or tendency to evacuate an area, the greater was the long-run change in the vegetation. The more seed-bearing annuals populated the lately opened spaces, the more fruit-bearing trees and shrubs encircled such openings, the more root plants were subdivided by digging, the more did plant food become available to man. A continuing cycle was thus set up. Perhaps man also harvested an increasing percentage of the plant food for himself and shared less with other mammals. As in modern agriculture, so in early collecting, a shift from animal to plant food yielded more calories per unit of surface. As man became more vegetarian in habit, he could support larger numbers of his kind. Every increase in his skill of reducing forest area, of harvesting seed, of digging roots, of cooking, of storage, raised the ceiling of population for him and, in most instances, exerted selective pressure in favor of the plants most useful to himself.

THE WOLF CREEK GLACIERS, ST. ELIAS RANGE, YUKON TERRITORY*

ROBERT P. SHARP

WOLF CREEK VALLEY lies on the northeast flank of the lofty St. Elias Range in the Yukon Territory of Canada about 25 miles east of the Alaskan border (see inset of Figure 1). Within the area studied (Fig. 1), extensive dissection has produced a rugged topography with a relief of about 7000 feet; Wolf Creek Valley itself averages 4000 to 5000 feet in depth. Elevations do not exceed 11,000 feet, but not far away to the west and south are Mt. Wood, 15,880 feet, and Mt. Steele, 16,644 feet. For the lower six miles Wolf Creek Valley is a broad, U-shaped glacial trough through which the stream flows; the rest of the valley is occupied by Wolf Creek Glacier, a trunk ice stream fully 25 miles long, which is stagnant from the sharp mid-point bend (Fig. 1) to the snout. In the valley north of Mt. Wood lies the relatively large North Fork Glacier, the lower three-eighths of a mile of which is also stagnant. This stagnancy is thought to have developed within the last hundred years. Most of the other glaciers in the area are retreating in the usual manner, but a few small tributaries were advancing in 1941.

In addition to tributary glaciers there are, on broad spurs between the tributary valleys, small icecaps or spur caps (Fig. 2). They are usually 100 to 250 feet thick and cover several square miles. Crevasses in lobate projections indicate flowage, and small moraines lie along the lower edges of these caps. It seems unlikely that spur caps do much work, but they leave marks of glaciation that might be erroneously interpreted as indicating much larger valley glaciers than actually were present.

The coastal ranges of Alaska have long been famous for their splendid glaciers. They are largest and most numerous on the seaward slopes, where

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* Expeditions under the auspices of the American Geographical Society and headed by Walter A. Wood carried on field exploration and photogrammetrical mapping in the Wolf Creek area during the summers of 1935, 1936, and 1939. In 1941 the Fourth Wood Yukon Expedition to Wolf Creek, of which the author was a member, provided opportunity, from June 26 to September 6, for a study of the glaciers, some of the results of which are presented here. The history of the advance, retreat, and stagnancy of the glaciers is reserved for another report.

Every member of the "7-man" expedition assisted in the scientific work, and special appreciation is extended to Walter A. Wood, who most ably organized and led the party. The U. S. Army Air Corps furnished personnel and equipment for aerial delivery of supplies (W. A. Wood: The Parachuting of Expedition Supplies, *Geogr. Rev.*, Vol. 32, 1942, pp. 36–55). The University of Illinois Graduate School Research Board provided funds for transportation, and a grant from the Graduate School of the University of Minnesota aided in the preparation of the manuscript and illustrations.

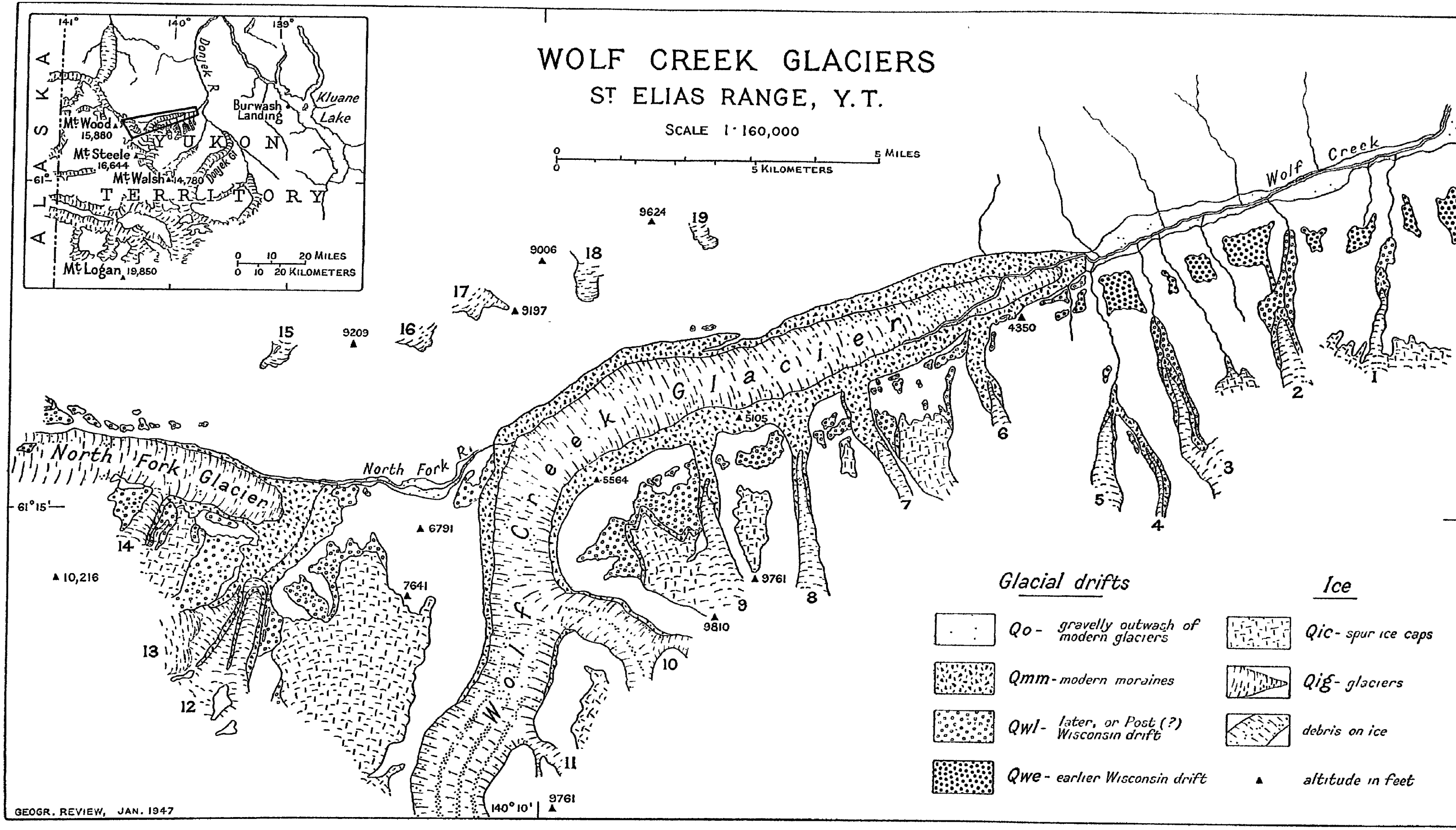

FIG. 1—Map of Wolf Creek glaciers. For easy reference the tributary glaciers are numbered clockwise from 1 to 19, beginning on the south wall of the main valley. Blank areas are bedrock. The map, constructed by the author with plane table and Brunton compass in 1941, is based on a triangulation system established by W. A. Wood.

moist air from the Pacific yields a heavy snowfall and the orographic snow line is at elevations of 2000 to 3000 feet. On the semiarid interior slopes, where the annual precipitation may be as little as 11 to 12 inches, conditions are different; in the Wolf Creek area the orographic snow line is at 8000 to 9100 feet. Because it lies in a dry region, where ablation is great, and because it contains both active and stagnant glaciers, the Wolf Creek area provides an exceptionally rich display of the surface features of glaciers. It is with these features, and related internal structures, that the present report is concerned.

Superimposed and Inset Ice Streams

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[1] P. C. Visser: Gletscherüberschiebungen im Nubra- und Shyock-Gebiet des Karakorum, *Zeitschr. für Gletscherkunde*, Vol. 20, 1932, pp. 29–44, reference on pp. 33–39; R. v. Klebelsberg: Die Zusammensetzung der Talgletscher, *ibid.*, Vol. 26, 1938–1939, pp. 22–44, reference on pp. 23–35; *idem:* Visser's Karakorum-Glaziologie, *ibid.*, pp. 307–320, reference on pp. 310–311; H. B. Washburn, Jr.: The Harvard-Dartmouth Alaskan Expeditions, 1933–1934, *Geogr. Journ.*, Vol. 87, 1936, pp. 481–495, reference on p. 488; N. E. Odell: The Glaciers and Morphology of the Franz Josef Fjord Region of North-East Greenland, *ibid.*, Vol. 90, 1937, pp. 111–125 and 233–258, reference on pp. 118–119 and 121–122.

[2] Similar differential activity in affluent ice streams has been described for the Karakoram. See W. H. Workman: Features of Karakoram Glaciers Connected with Pressure, Especially of Affluents, *Zeitschr. für Gletscherkunde*, Vol. 8, 1913–1914, pp. 65–103; reference on pp. 67–69.

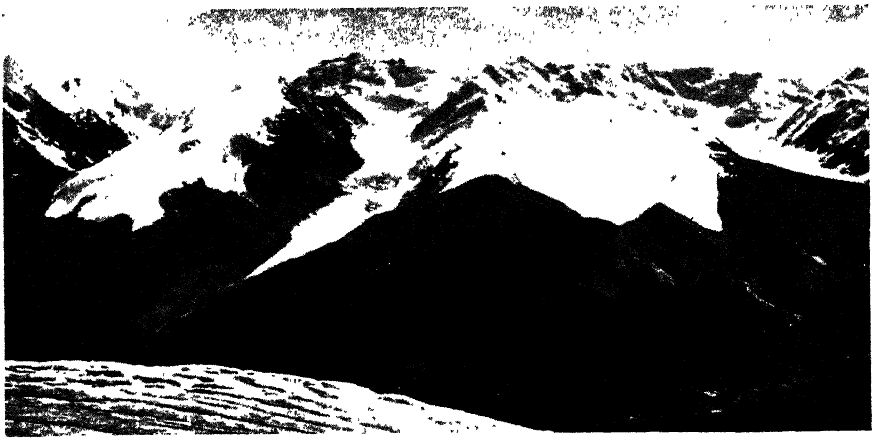
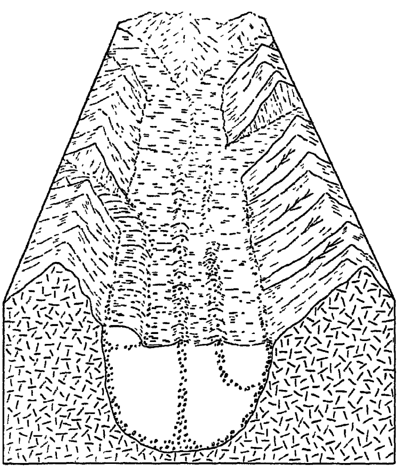


FIG. 2—Small icecaps on broad spurs between tributary valleys on the south wall of Wolf Creek Valley. Looking south-southeast from the surface of Glacier 18, July 22, 1941.



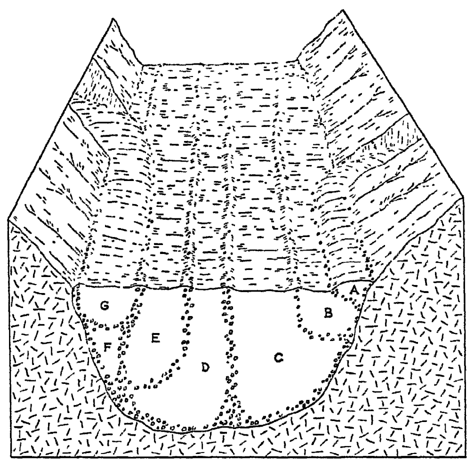


FIG. 3—Diagrammatic sketch of parallel, inset, and superimposed ice streams in a trunk glacier.
FIG. 4—Diagrammatic sketch of the internal structure of a complex valley glacier.

FIG. 5—Snout of Glacier 13, on the east slope of Mt. Wood. This is a small superimposed glacier advancing rapidly onto the surface of the valley glacier at the left. The vertical ice front is about 150 feet high. View southward, July 18, 1941.

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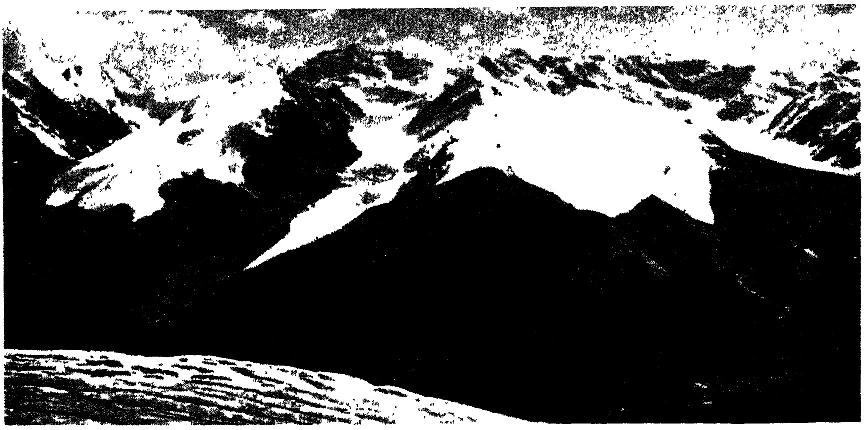

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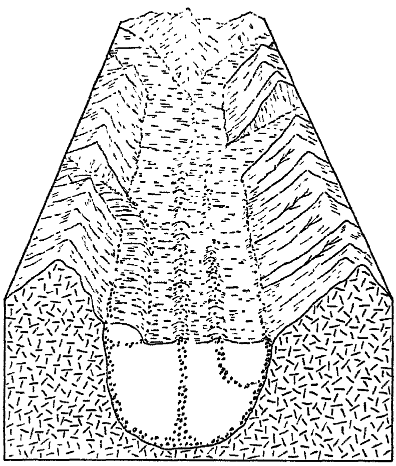

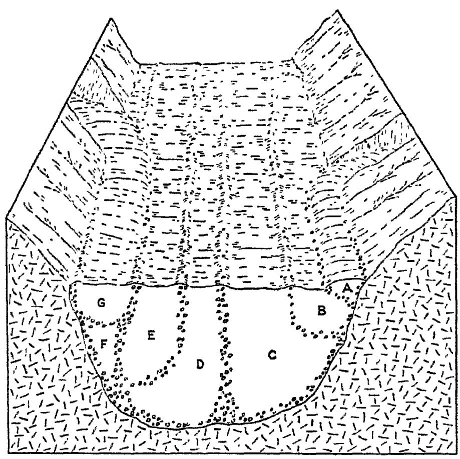

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The most important factor determining the position taken by a tributary ice stream upon joining a trunk glacier is the accordance or discordance of the valley floors. Size, vigor, and time of arrival at the junction have smaller or more temporary influence. A parallel position usually results if the valley floors are concordant. If the trunk glacier reaches the junction first, it forms a barrier across the mouth of the tributary, and some of its ice flows a short distance up the side valley by extrusion and obstructed extrusion flow.[3] When the advancing tributary, moving by gravity flow, reaches this barrier, it rides up onto the sloping ice face, which becomes in effect part of the gravity-flow system. At this point gravity flow in the tributary is opposed by extrusion flow in the trunk glacier, and the tributary thickens by obstructed extrusion flow. As its thickness increases, the potential for extrusion flow from the trunk glacier decreases. A waxing force is thus pitted against a waning force, and eventually the gravity-flow system triumphs. The tributary forces its way into the main valley and takes a position parallel to the trunk glacier, causing an increase in thickness in the trunk glacier upstream and downstream from the junction. These changes in thickness probably take place by lateral extrusion flow and down-valley obstructed extrusion flow.

If the tributary glacier reaches the junction first and extends into the main valley, it may subsequently be overwhelmed by the trunk glacier. In time, however, the interplay of gravity flow and extrusion flow outlined above is repeated, and a parallel position develops.

If the valley floors are discordant and the trunk glacier is thick enough to raise a barrier across the tributary valley, an inset relation develops by the process outlined. If the discordance is so great that no ice barrier lies across the tributary valley, a superimposed relation results, at least at the junction.

A tributary advancing with extreme rapidity might conceivably become temporarily superimposed on the trunk glacier regardless of valley accordance or barrier height. However, a wholly superimposed position is usually short-lived; for the superincumbent ice load gradually displaces the ice beneath so that the tributary becomes partly, and eventually completely, inset. Only a tributary moving very rapidly, or one so small that it can be supported by the rigidity of the crust on the trunk glacier, will have a wholly superimposed position any distance below the junction.

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[3] Max Demorest: Glacier Thinning during Deglaciation, Part I, Glacier Regimens and Ice Movement within Glaciers, *Amer. Journ. of Sci.*, Vol. 240, 1942, pp. 29–66; reference on pp. 32–38.

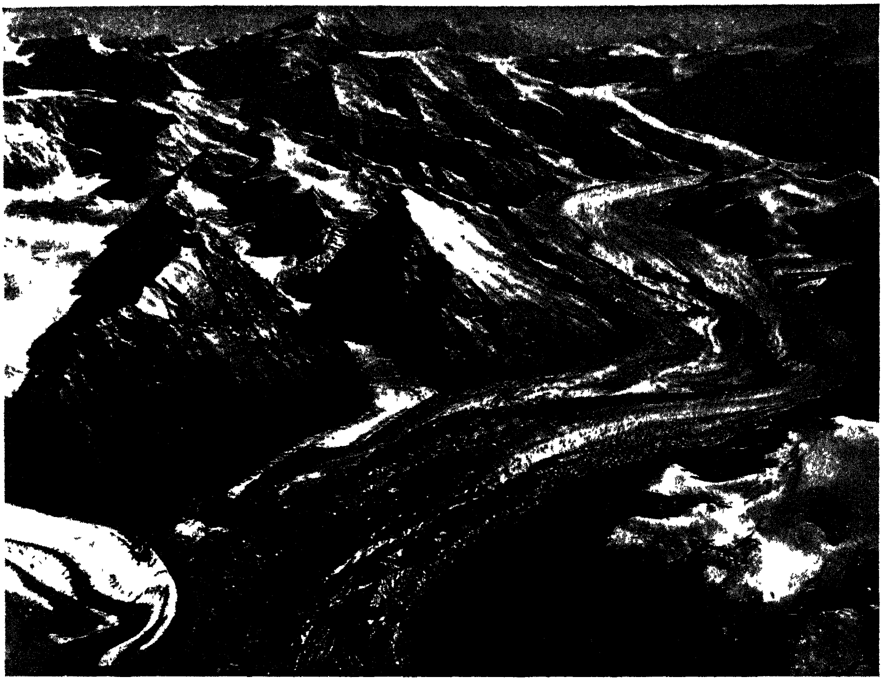

FIG. 6—Upper Wolf Creek Glacier above the bend in the valley, showing some of its tributaries and the several ice streams of which it is composed. Aerial photograph by W. A. Wood, 1941.

INTERNAL STRUCTURES OF GLACIERS

Nearly all glaciers exhibit a ribboned structure—thin parallel bands of solid blue ice alternating with thicker bands of porous white ice. Although many modes of origin have been advocated, the present consensus[4] is that they represent planes of strain along which the ice has been recrystallized. No evidence was found on Wolf Creek to indicate that the ribboned structure is in any way related to stratification of the névé fields. On glacier surfaces this structure is accentuated by differential melting, the blue bands, curiously, melting faster in some places than the white. This probably occurs where melting is caused principally by direct radiation, which is more effective in melting ice than snow and therefore probably melts solid blue ice more rapidly than porous white ice. Surficial debris collects along the more rapidly melting bands, but this does not indicate a greater initial content of detritus;

[4] W. H. Sherzer: Glaciers of the Canadian Rockies and Selkirks, *Smithsonian Contributions to Knowledge*, Vol. 34, 1907, Art. 4, pp. 43–44; H. Philipp: Untersuchungen über Gletscherstruktur und Gletscherbewegung, *Geol. Rundschau*, Vol. 5, 1914, pp. 234–239; R. T. Chamberlin: Instrumental Work on the Nature of Glacier Motion, *Journ. of Geol.*, Vol. 36, 1928, pp. 1–30, reference on pp. 23–24; F. E. Matthes: Glaciers, *in* Hydrology (Physics of the Earth, Vol. 9), edited by O. E. Meinzer, New York and London, 1942, pp. 149–219, reference on pp. 171–172.

FIG. 7—Large superglacial blocks of granite on upper Wolf Creek Glacier. The largest shown is about 15 feet long.

FIG. 8—Well-rounded stream-worn stones in Wolf Creek glacial debris.

for vertical sections show no consistent difference in the detrital content of white and blue ice. In the central part of an ice stream the bands are usually within a few degrees of vertical, and their traces on the glacier surface parallel the valley walls until they near the glacier snout, where they curve across the ice surface to meet bands from the opposite side and dip at moderate angles up the valley. At the lateral margins the bands dip steeply inward except in places where the ice is not pressing against the valley wall. In these places they bend over into horizontal or outward-dipping positions.

Debris-rich bands concordant with the ribboned structure are numerous along the edges and near the snouts of glaciers. They appear to be shears along which detritus has been carried into the ice.[5] This probably occurs at least in part by obstructed types of flow.[6] Some debris-rich bands are faults and shears along which the ribboned structure has been displaced and deformed. Others may have been open fractures that subsequently filled with detritus.

Veins of blue ice, two inches to two feet thick, cut discordantly across the ribboned structure. They appear to be fillings of open fractures or cracks widened by growth of ice crystals. The crystals are perpendicular to the walls of the vein and join in a jagged central suture locally coated with a

[5] Not to be confused with these are the wholly superficial Forbes "dirt-bands" (see J. D. Forbes: Occasional Papers on the Theory of Glaciers, Edinburgh, 1859, pp. 25, 39–41, and 213–214) appearing on the surface of some valley glaciers below icefalls. In spite of careful search, no true Forbes dirt bands were found on Wolf Creek glaciers, though the numerous icefalls and vigorous ablation of the area would seem to favor their development. For a recent thorough study of this feature see two publications by J. E. Fisher (privately printed), "Forbes' Dirt Bands on Glaciers," 1942, pp. 1–17, and "Problems in the Geology of Mountains," 1944, pp. 26–40.

[6] Max Demorest: Ice Sheets, *Bull. Geol. Soc. of America*, Vol. 54, 1943, pp. 363–399, reference on pp. 366–373; Matthes, *op. cit.*, p. 180.

white, tasteless powder, presumably a residue from the crystallization.

SUPERGLACIAL DEBRIS[7]

The debris mantle on Wolf Creek glaciers ranges from a mere sprinkling to a continuous cover one foot to three feet thick, with somewhat greater thicknesses along debris-rich bands and near glacier margins where the bottom layers of ice, carrying the greatest load of detritus, outcrop. The total amount of debris is not as great as the superficial appearance might suggest (Fig. 24). If it were uniformly distributed, the average thickness would not be more than a foot or two.

FIG. 9—Pond deposits in superglacial mantle of North Fork Glacier. Note layers of coarse debris, and folds attributable to the impact of large stones falling from adjacent ice walls. Truncation of the folds indicates that they were formed while the material was accumulating.

In summer this material, which ranges from fine silt to huge blocks tens of feet in diameter (Fig. 7), is shifted by running water, mass movements, and free fall initiated and controlled largely by differential melting and stream cutting. That these movements accomplish some breaking of the fragments is shown by percussion marks and chips on some of the boulders. Reduction of size is effected also by weathering, especially by frost action, the efficacy of which is demonstrated by numerous chips around boulders on the ice and by the complete shattering of some bedded and foliated rocks.

By these movements the debris is sorted to some degree. Crude sorting may, however, be accomplished in other ways. For example, in a wedge-shaped crevasse narrowing downward smaller fragments can fall to deeper levels. This sorting in the vertical can be transferred to the horizontal as the glacier melts and various levels of the debris-filled crevasses are exposed. Linear accumulations of large boulders on Wolf Creek Glacier seem to be of this origin.

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[7] Unless otherwise specified, this discussion deals with material on stagnant ice.

On active ice in this area the fragments are almost universally angular, and, in general, angularity predominates. However, overemphasis on this feature by some writers leaves one ill-prepared for the many well-rounded stones (Fig. 8) in the debris of these and other glaciers. Long, sinuous deposits of rounded pebbles and sorted sand mark the former courses of superglacial streams, now abandoned because of differential melting. The great amount of waterworn and water-sorted debris in the superglacial mantle is noteworthy.

At the mouths of tributary valleys emptying onto a trunk glacier alluvial fans are built. Although they may be prominent locally, they constitute only a minor part of the superglacial mantle. Those on Wolf Creek Glacier show no down-valley movement, thus demonstrating the inactivity of the glacier.

Ponds on the glacier surface are the sites of accumulations of well-bedded sand and silt containing occasional angular stones and interbeds of coarse angular gravel (Fig. 9). The fine material is washed in by streams or supplied by free fall and mass movement from the mantle on the surrounding ice slopes. Coarse debris comes from the latter source only.

Probably less then 10 per cent of the debris on Wolf Creek Glacier has been superglacial from the start. Most of it is englacial material that has been concentrated on the surface by melting, as can be seen by following an ice stream from its clean headward part down-glacier to the debris-covered lower section. Some material exposed by melting must have been carried away by meltwater, but, even so, the ice cannot have been heavily laden with englacial detritus; for in the stagnant part of Wolf Creek Glacier it has taken the melting of at least five hundred feet of ice to produce the thin superglacial mantle. The numerous striated and faceted stones suggest that at least some of the englacial material was originally subglacial, carried up into the ice along shear surfaces or brought in as ground moraine of superimposed and inset ice streams.

Surface Features of Debris-Mantled Ice

Glacial Tables. Isolated rock fragments left perched on ice pedestals because they protect the ice beneath from melting are called glacial tables. Such differential melting is possible only when the air temperatures are low, so that melting of shaded ice, accomplished by reflected radiation and conduction of heat from the surrounding air, is less than the melting of ice exposed to direct insolation. The zone most favorable to development of glacial tables moves up the glaciers as the summer advances. In this region by mid-August it was well up toward the firn line. In the fall, the zone

probably moves down-glacier again, until overtaken by the descending snow line.

Development of glacial tables depends in part on the abundance and nature of the rock fragments. Tables are most numerous in areas covered by a sparse mantle containing relatively large fragments. Below a certain minimum size, which increases as the season becomes warmer,[8] fragments melt into the ice rather than protect it from melting. Color, lithology, shape, and position of the fragment are also significant. On one glacier a slab of white marble two inches thick and ten inches wide had formed a table by mid-July, whereas a near-by diabase of about the same width but fully ten inches thick had melted into the ice. This is probably attributable largely to the greater absorption of radiant energy by the dark diabase, and perhaps in part to its slightly greater thermal conductivity. In other cases differences in thermal conductivity may be more significant, for it varies considerably from one type of rock to another.[9] It was also noted that flat, slabby pieces of rock casting broad shadows form tables, whereas smaller fragments of the same thicknesses do not.

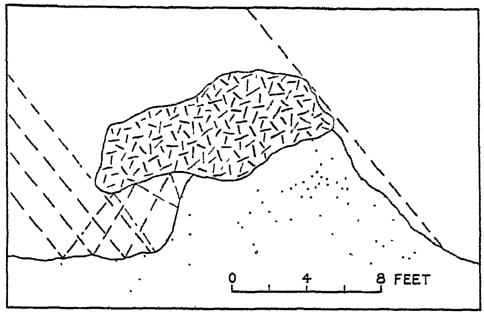


FIG. 10—Sketch of glacial table showing how, in the Northern Hemisphere, reflected radiations on the south (left) side, causing greater melting there, may produce a southward tilt. Local variations in the slope of the ice surface or the shape of rock fragments may outweigh sun position and cause tilts in other directions. In the Wolf Creek area the tilt, seldom greater than 25°, is 20° to 30° west of south.

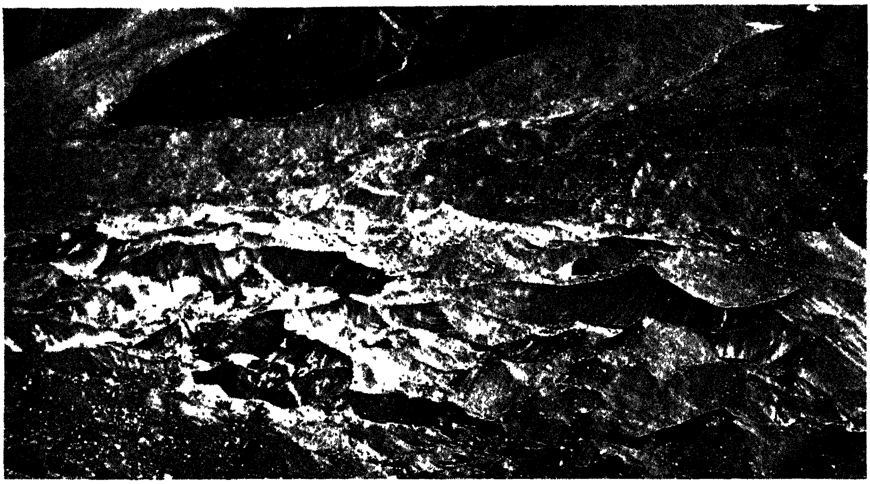
Wolf Creek tables commonly have the southward tilt characteristic of the Northern Hemisphere, where melting is greater on the south side (Fig. 10). The pedestals range in height from less than an inch to four feet. As this maximum height is approached, the tilted boulders become unstable and are dislodged, leaving pedestal-type pinnacles, or *nieve penitente*.[10]

Debris-Covered Ice Mounds and Ridges. Irregular mounds, cones, and ridges of ice protected by a mantle of superglacial debris are formed by more rapid melting of the more thinly covered surrounding ice. Such forms, as much as

[8] For more extended treatment of this matter see Fritiof Fryxell: The Formation of Glacial Tables, Grand Teton National Park, Wyoming, *Journ. of Geol.*, Vol. 41, 1933, pp. 642–646.

[9] Francis Birch, J. F. Schairer, and H. C. Spicer, edits.: Handbook of Physical Constants, *Geol. Soc. of America Special Paper No. 36*, 1942, pp. 253 and 255–256.

[10] W. H. Workman: Nieve Penitente and Allied Formations in Himalaya, or Surface-Forms of Névé and Ice Created or Modelled by Melting, *Zeitschr. für Gletscherkunde*, Vol. 8, 1913–1914, pp. 289–330; reference on pp. 320–323.



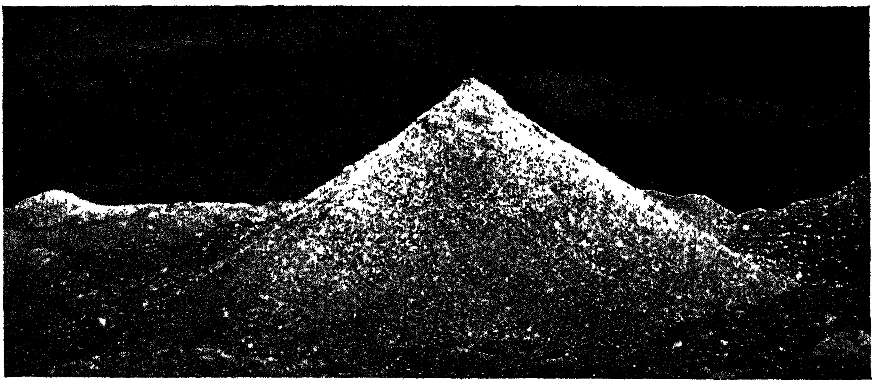


FIG. 11—Chaotic topography and superglacial mantle of stagnant lower Wolf Creek Glacier, seen from its north side. Dirty ice faces shown are 150 to 200 feet high. July 15, 1941.

FIG. 12—Debris-covered ice mound formed through protection afforded by a localized deposit of relatively well-sorted gravel.

FIG. 13—Kinks in dark medial moraine on upper Wolf Creek Glacier. These are attributed to shoving by a rapidly advancing tributary glacier, at the mouth of which a small kink is in process of formation. The more prominent kink has moved more than a mile down-valley from its point of origin.

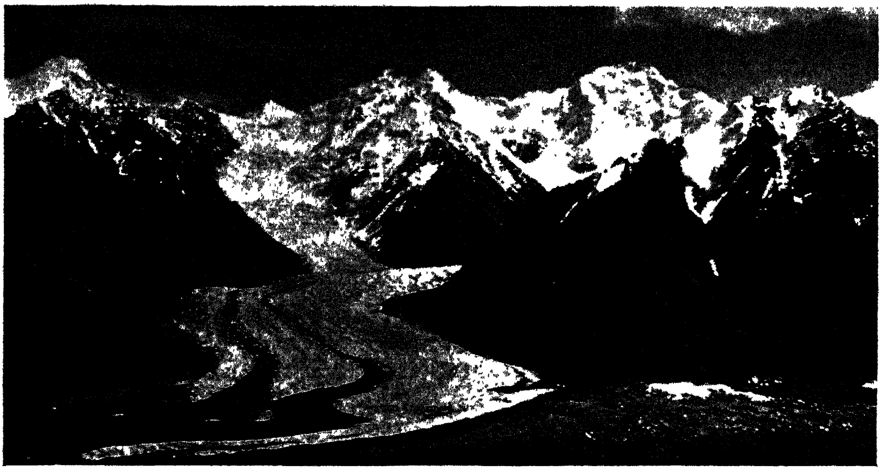


FIG. 14—Medial moraines on Glacier 10. In their lower parts the moraines increase in height and width; for as additional englacial debris is exposed at the surface by melting, some of it is distributed laterally by running water and mass movement. Note the mild contortion at the junction with Wolf Creek Glacier. View southeast, July 4, 1941.

FIG. 15—Cross moraine on Glacier 12 formed along outcrop of debris-rich band in the ice. Vertical snout of small superimposed glacier in background. Looking west-southwest, July 7, 1941.

FIG. 16—Cross moraine at terminus of inset ice stream on Glacier 8. August 11, 1941.

150 feet in height, are numerous in the stagnant part of Wolf Creek Glacier (Fig. 11) and in areas of active ice where the debris is irregularly distributed and ablation is great.

The characteristics of these features depend on variations in the composition and distribution of the superglacial debris. Localized deposits of reasonably homogeneous material form conical debris-covered ice mounds (Fig. 12). Symmetrical ridges and chains of mounds usually mark the traces of linear bands of ice especially rich in debris, such as medial and lateral moraines (Figs. 13 and 14) or cross moraines (Figs. 15 and 16).

A cover of varying thickness produces irregularities and instability, but a uniform cover serves to stabilize existing topography. A mound or ridge of ice so extensively and thickly mantled that almost no melting occurs maintains or even increases its size until the mantle is disturbed by stream action, internal ice movements, or mass movements within the debris initiated by heavy rainfall or melting snow. A mound wholly or partly stripped of its debris undergoes rapid changes in size and shape by melting of the exposed ice. Complete inversions of relief often occur, present high points becoming depressions and vice versa. These changes have been named the ablation cycle.[11] Comparisons of photographs taken in 1935 with the features of Wolf Creek glaciers observed in 1941 reveal minor changes in topographic details but no major inversions. A period of several decades may be required to complete the ablation cycle here.

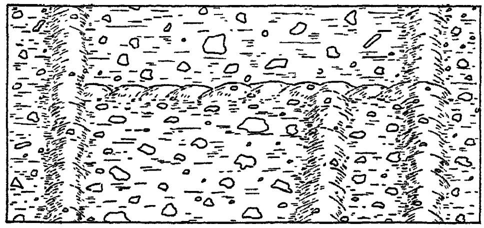
The thickness of debris necessary to form an ice mound or ridge depends partly on grain size. Layers of coarse sand half an inch to three-fourths of an inch thick may provide sufficient insulation for the development of mounds, though their usually moist condition shows that they do not prevent melting entirely. Mantles of coarse debris must be a foot or two thick to provide equivalent protection. The difference must be due in part to the greater ease with which air circulates through the larger interstices in coarse material.

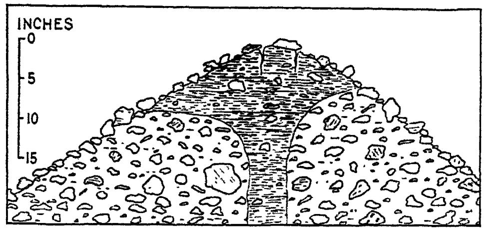
Mud Ridges. Low, rounded ridges of mud in the midst of coarse, poorly sorted detritus on relatively level areas of stagnant ice attract immediate attention (Fig. 17). Excavations reveal that the ridges mark the sites of mud-filled cracks in the underlying ice (Fig. 18). As downmelting of the ice leaves the filling of the cracks standing in relief, the exposed mud thaws and flows laterally. Longitudinal cracks in the mud may be due to this lateral flowage or to desiccation. Mud-filled cracks outcropping on a steep

[11] G. K. Gilbert: Glaciers and Glaciation [of Alaska] (Harriman Alaska Expedition, Vol. 3), New York, 1904, pp. 198–202.

slope do not form ridges but supply material for mudflows.

Debris-Mantled Ice Shelf. Previous descriptions of this feature have not been found. It is a level or gently sloping debris-covered shelf on a nearly vertical ice face (Fig. 19). The largest seen was 20 feet wide and 100 feet long. Invariably a shelf is concordant with a dirt band in the ice and forms by more rapid melting and retreat of the ice face above the dirt band. The debris on the shelf is in part a residual accumulation from the dirt band and in part an accumulation of material falling from above. By diverting meltwater the shelf retards melting of the ice face below it. Shelves form most readily where the dirt bands dip gently into the ice face. If they dip outward, the debris slides off, meltwater continues down the face, and no shelf is formed. Like other debris-mantled ice features, they are ephemeral.





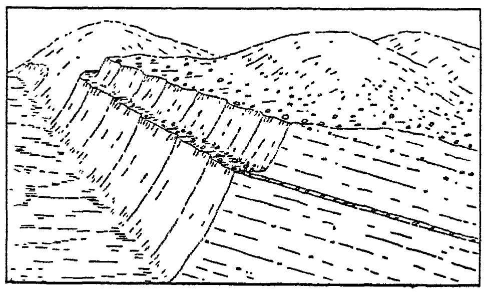


FIG. 17—Field sketch of mud ridges in superglacial mantle of North Fork Glacier. These ridges, formed along traces of mud-filled cracks in the ice, are 12 to 18 inches high and in some places form intersecting sets.

FIG. 18—Cross-section sketch of excavated mud ridge in superglacial mantle. Note the presence of occasional stones in the mud and on the ridge surface.

FIG. 19—Diagrammatic sketch of debris-mantled ice shelf. The shelf as sketched is about 10 feet wide.

DUST WELLS AND DUST BASINS

In areas of relatively clean glacier ice localized melting under thin accumulations of dark silt forms depressions or *Kryokonitlöcher,* first described by A. E. Nordenskiöld in 1870.[12] Two types, dust wells and dust basins, both typically filled with water, are common on Wolf Creek. Dust wells, with which the ice is in places literally perforated (Fig. 20), are small vertical cylindrical holes, circular or, in the case of some of the larger

[12] A. E. Nordenskiöld: Redegörelse för en expedition till Grönland år 1870, *Öfversigt af K. Svenska Vetenskaps-Akad. Förhandl. 10,* 1870.

ones, oval, oblong, or crudely scalloped. In this area they are one-fourth of an inch to 3 inches in diameter and 4 to 8 inches deep.[13] Associated with them, and sometimes formed by the integration of adjacent wells, are larger, semicircular basins (Figs. 21 and 22), the largest of which was 3 feet long, a foot and a half wide, and 12 to 16 inches deep.[14] One cryoconite pool was seen. This depression was 60 feet long, 30 feet wide, and 12 to 15 feet deep.

FIG. 20—Surface of upper Wolf Creek Glacier perforated with dust wells. August 6, 1941.

FIG. 21—Crescent-shaped dust basin on upper Wolf Creek Glacier. This basin, 12½ inches deep, was nearly filled with water. August 12, 1941. The elongation of the basins in this area is typically east-west and is usually independent of the surface slope and internal structure of the glacier. In northern latitudes lateral enlargement is accomplished chiefly through melting of the north, east, and west walls by direct insolation. Evidently the combined retreat of the east and west walls exceeds that of the north wall.

It contained water about 3 feet deep and had a thin, irregular mantle of dark bottom silt.

The fine debris found in all these depressions is usually called dust, and some writers specifically speak of it as wind-blown. It could, however, be distributed partly or entirely by meltwater, in which case the terms "dust well" and "dust basin" would not be wholly appropriate. *Kryokonitlöcher* is as a rule even more inappropriate, since "cryoconite" was proposed by Nordenskiöld for dust of cosmic origin. However, since usage has estab-

[13] Depths of as much as 24 inches have been recorded in North Greenland. See Erich von Drygalski: Grönland-Expedition der Gesellschaft für Erdkunde zu Berlin, 1891–1893, 2 vols., Berlin, 1897; reference in Vol. 1, pp. 95 ff.

[14] In North Greenland depths of some 30 inches have been recorded. See "Deutsche Inlandeis-Expedition nach Grönland Sommer 1929 unter Leitung von Alfred Wegener," *Zeitschr. Gesell. für Erdkunde zu Berlin*, 1930, pp. 81–124; reference on p. 93.

lished this terminology, it will be followed regardless of the origin of the bottom silt.

The depressions that cause the initial uneven distribution of the silt may be formed by intergranular melting or excessive localized melting of porous air-filled ice, in which the wells and basins of this region are chiefly developed. Clear ice, with smoother surfaces, can, in relatively temperate

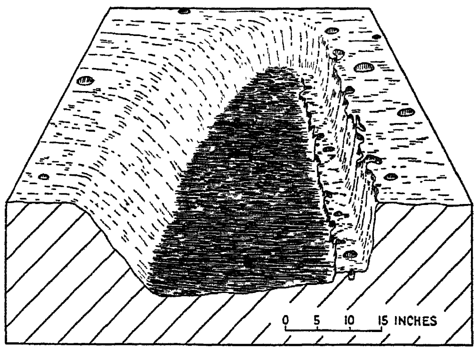


FIG. 22—Diagrammatic sketch of dust basin showing typical asymmetrical north-south cross section. The smooth north (left) wall has a slope about normal to the sun's rays; the south wall, which is in shadow most, if not all, of the time, is nearly vertical and is irregularly indented by remnants of incompletely digested wells overtaken by the retreating wall. On the basin floor near the foot of the south wall a low, irregular step or sill marks the edge of the midday shadow. The rest of the floor slopes gently northward. The northern part, exposed to direct insolation, melts most rapidly. Silt, moving down the resulting slope, accumulates at the north, causing greater absorption of insolation and further deepening until the silt becomes thick enough to provide insulation.

areas such as this, be washed clean of fine debris by meltwater. But where air temperatures are always below the freezing point, and little meltwater develops, silt could accumulate and form wells and basins in clear ice.

By their greater absorption of radiant energy the thin localized accumulations of fine dark debris initiate differential melting. This is known as indirect ablation, in contrast with direct ablation, which is accomplished largely by contact with warm air. Indirect ablation by exposure of the silt to direct insolation cannot extend beyond the depth at which the bottom of the depression is continuously shaded by the walls, but many wells are so deep that the bottoms and the lower parts of the walls are completely shaded. To account for the deepening of such holes beyond the limit of direct solar radiation, several hypotheses have been advanced. Drygalski[15] favors the sinking of warmed surface water to the bottom of the hole. Theoretically, this could occur, because of the greater density of water at 4° C. than at 0° C. Philipp, Poser, and Wagner[16] each favor the idea that the deepening is

[15] *Op. cit.*, Vol. 1, p. 100.

[16] H. Philipp: Über die Beziehungen der Kryokonitlöcher zu den Schmelzschalen und ihren Einfluss auf die Ablationsverhältnisse arktischer Gletscher, *Zeitschr. Deutsch. Geol. Gesell.*, Vol. 64, 1912, B. Monatsber., pp. 489–505, reference on pp. 489–491; Hans Poser: Über Abschmelzformen auf dem ostgrönländischen Packeise und Landeise, *Zeitschr. für Gletscherkunde*, Vol. 21, 1933–1934, pp. 1–20, reference on p. 9; A. Wagner: Zur Entstehung von Kryokonitlöchern, *ibid.*, Vol. 26, 1938–1939, pp. 129–137, reference on pp. 133–137.

FIG. 23—Wolf Creek emerging from its englacial tunnel 2 miles above snout of glacier. Numerous floes indicate considerable erosion of the englacial channel. August 22, 1941.

FIG. 24—Pond on surface of lower Wolf Creek Glacier. Note abandoned shore lines, dipping debris bands, and debris-mantled ice mound in the background. Observe that the debris mantle is extensive but surprisingly thin. August 22, 1941.

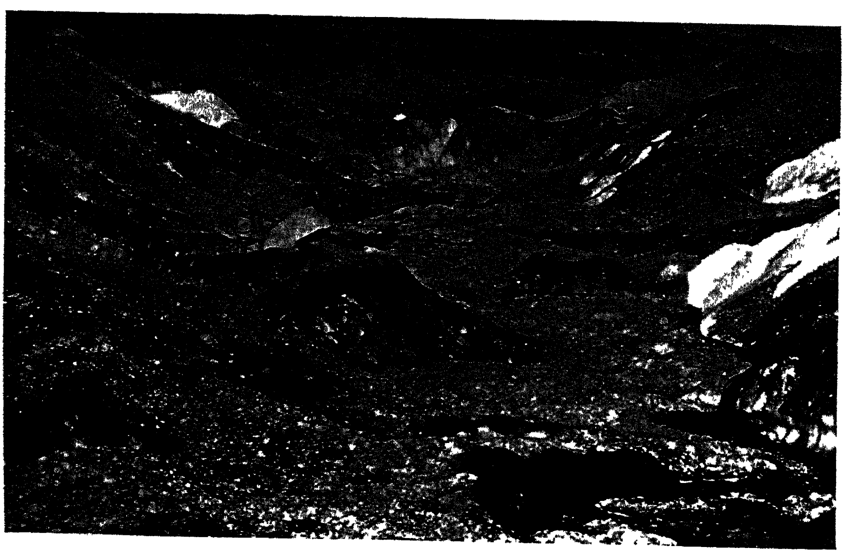


FIG. 25—Small stream and its valley on Wolf Creek Glacier below the bend. Walls of valley

produced by radiations transmitted obliquely through the ice to the silt. Steinböck[17] reports that organisms living in the mud generate some heat, which may be a factor in deepening the wells. He also holds that diffused radiations from the sky reach the bottoms of wells. Under ideal conditions diffused heat rays may constitute as much as one-eighth to one-third of the total solar radiation,[18] and at very low solar altitudes the "sky radiation" on a horizontal plane is more intense than direct solar radiation.[19] Final conclusions as to the comparative efficiency and significance of these various factors do not yet appear possible, though it would seem that transmitted radiations are of major importance and diffused radiations cannot be entirely discounted.

Field observations and experiments[20] show that in clear, cold weather, when the sun shines directly on the ice, indirect ablation proceeds more rapidly than direct ablation, a condition favoring development of wells and basins. Such indirect ablation may take place at air temperatures far below the freezing point and may be a major factor in glacier ablation in high latitudes and at high altitudes. In warm, cloudy weather direct ablation proceeds more rapidly. This is unfavorable to development of dust holes and may eventually lead to their destruction. The maximum depth attained by the holes is ultimately controlled by the relative rates of direct and indirect ablation. In some areas there is a seasonal variation, wells and basins being deeper in spring and early summer than later in the season, when direct ablation is greater. In the Wolf Creek area a seasonal variation in the distribution of wells and basins was also noted. In the late summer they were limited to a narrow zone lying just below the firn line. Their absence from lower parts of the glaciers is attributed to superiority of direct ablation there. The zone of dust wells and basins probably moves slowly up the glaciers as the summer advances, following the retreating snow line.

It has been suggested[21] that dust basins predominate in middle latitudes, where direct radiation is relatively more effective, and dust wells in high latitudes, where direct radiation is less effective than diffused radiation. Neither form need be wholly excluded from either environment, as is shown

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[17] O. Steinböck: Über Kryokonitlöcher und ihre biologische Bedeutung, *Zeitschr. für Gletscherkunde*, Vol. 24, 1936, pp. 1–21; reference on pp. 10–11.

[18] H. G. Lundegårdh: Environment and Plant Development, translated and edited from the second German edition by Eric Ashby, London, 1931, p. 14.

[19] C. S. Wright and R. E. Priestley: Glaciology (British [Terra Nova] Antarctic Expedition, 1910–1913), London, 1922, p. 5.

[20] B. Brandt: Beobachtungen und Versuche über die Entwicklung der Kryokonitformen, *Zeitschr. für Gletscherkunde*, Vol. 20, 1932, pp. 84–93.

[21] Steinböck, *op. cit.*, pp. 6, 9–11, and 19–20.

by the presence of both in the Wolf Creek area. It may be that integration of wells to form basins occurs less easily in areas where the air temperature is continuously below the freezing point than in warmer areas, because back-melting of the walls is less. Thus air temperature may be one of the fundamental factors accounting for the abundance of wells and scarcity of basins in far northern latitudes. It is possible that wells in temperate regions, such as the Wolf Creek area, are formed chiefly in the spring and fall and basins develop largely in midsummer, when the air temperature rises above the freezing point for longer periods.

Glacier Ponds

Ponds and lakelets on the ice surface are most numerous near the snouts of stagnant glaciers. A roughly circular shape predominates, with diameters of 50 to 1000 feet. Few ponds have visible outlets, but the relatively large amounts of water supplied by glacial streams and by melting of the surrounding ice slopes necessitate a subaqueous outlet.

Basins may be formed by collapse of englacial and subglacial passages or by enlargement of parts of crevasses by melting, but these modes of origin were not common on Wolf Creek Glacier. Here some basins were apparently formed by more rapid melting of clean ice in the midst of debris-protected ice, whereas others occupy depressions on the floors of abandoned stream channels or parts of stream valleys dammed by slides.

When once formed, a pond enlarges its basin by melting the walls and floor with heat received by the surface water and carried to the periphery and bottom by convection currents. These currents locally produce vertical fluting on the ice walls. The horizontal undercutting thus accomplished, as much as five feet at water level, is most prominent on the south wall, because it is shaded and does not melt back above the undercut as fast as walls with other exposures. Abandoned shore lines may be recognized by this undercutting (Fig. 24). Collapse of the overhanging ice, usually along arcuate fractures, produces vertical cliffs as much as 75 feet high. Debris shed from these walls in summer constantly muddies the pond waters.

Glacier ponds are destroyed by lowering of surface outlets, enlargement of subaqueous outlets, back-melting of walls, filling with debris, or diversion of water supplies. Many of the ponds on lower Wolf Creek Glacier were destroyed by these processes in the six years between 1935 and 1941.

Stream Dissection of Ice

Streams are most numerous on relatively inactive ice, the water coming from melting directly, from drainage of ponds, or from springs fed by

englacial streams. Little comes from extraglacial sources; for such water, when it gains access to the glacier, causes exceptional melting and rapidly becomes englacial (Fig. 23). The volume of a stream on the ice is seldom more than a few cubic feet per second, and the valley is, at the most, 100 to 200 feet deep and two to three miles long, because the stream is diverted into an englacial channel before it reaches greater size. As a result of such diversions, examples of which were observed in the summer of 1941, abandoned stream valleys are numerous. These, together with the effects of ablation, mass movements of debris, collapse of overhanging walls, and formation of ponds, give a chaotic appearance (Fig. 11) to the dominantly stream-cut topography of stagnant ice (Fig. 25). Where superglacial debris is sparse, structures within the ice exert some control on the trend and arrangement of the smaller streams. If the course of a stream cuts across the banded structure of the ice, its tributaries may be subsequent on softer ice bands, and a typical rectangular drainage pattern results.

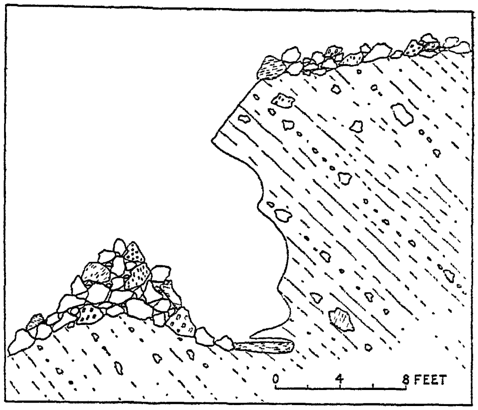


FIG. 26—Cross-section sketch showing debris embankment built at foot of overhanging ice face by material falling from above. This debris forces the near-by stream against the base of the ice slope, which is thereby undercut.

Gradients of superglacial streams are relatively steep and velocities high. Some streams flow so rapidly that they rise on the outer walls of curves like a toboggan in a racing course. When melting is rapid, the streams are turbid with suspended matter, and because of the low coefficient of friction in an ice channel even small streams can transport relatively large fragments by traction. The resulting mechanical corrasion is one factor in the erosion of the channels, enlargement of which is accomplished also by melting (which at the same time adds to the volume of the stream) and by solution[22] of the ice walls and floor. Embankments of debris that has fallen from above (Fig. 26) force the stream against one side of the valley, causing extensive under-

[22] The amount of ice that water can dissolve increases with decreased temperature (see N. E. Dorsey: Properties of Ordinary Water-Substance in All Its Phases [Amer. Chemical Soc. Monograph Ser., No. 81], New York, 1940, p. 164). However, since the water of glacial streams, derived largely from melting ice, must be nearly saturated with ice molecules, its capacity for further solution must be limited.

cutting. This and the meandering habit of most glacier streams account for the numerous slip-off slopes, undercut slopes, cutoff meanders, and natural bridges.

Flutes and Scallops

These features form on clean ice faces that receive little or no direct sunlight, such as the under sides of overhanging cliffs (Fig. 27) and the walls and ceilings of ice caves and arches. The contrast between fluted shaded surfaces and rill-cut surfaces exposed to direct sunlight is shown in Figure 28.

Flutes and scallops are clearly the product of differential melting, which is independent of any visible structure in the ice. Diffused and reflected radiations, conduction and convection in the atmosphere, and meltwater are probably all contributing factors, but in what way and to what degree is not clear. Elongation of flutes on slopes would seem to indicate that meltwater is a significant factor, but no satisfactory explanation has been found for the form and pattern of flutes and scallops.

Lateral Moraines

The term "lateral moraine" is applied to two types of deposit: (1) linear accumulations of debris on and within a glacier along the lateral margins; (2) debris deposited along the lateral edges of a glacier but not resting on the glacier surface. In this discussion only the latter type is considered. Such a lateral moraine consists of a single broad ridge or a series of smaller subparallel ridges or terracelike accumulations with crests successively lower toward the glacier. Even the largest moraines are little more than a hundred feet in height. Their linear aspect is modified by abandoned spillway channels (Fig. 29) cut by streams issuing from the glacier or flowing into it and by a characteristic dump-pile appearance. Internally the moraines are chaotic mixtures of angular blocks as much as 20 feet in diameter, rounded boulders and cobbles, well-sorted sand and gravel, unsorted bouldery and sandy silt, and well-bedded silt. These materials are usually segregated into small, irregularly shaped piles, though they may be intermixed or be so disturbed by erosion and mass movements that segregation is obscured.

In the Wolf Creek area lateral moraines can be seen in process of development. They are not of the lodge- or push-moraine type[23] but form as debris aprons[24] at the base of ice walls (Fig. 30). They are being built up in the

[23] T. C. Chamberlin and R. D. Salisbury: Geology, 3 vols., New York, 1904–1906; reference in Vol. 1, pp. 286–287.

[24] This debris-apron mode of morainal development has been well described by A. M. Bateman: Kennecott Glacier of Alaska, *Bull. Geol. Soc. of America*, Vol. 33, 1922, pp. 527–539; reference on p. 535.

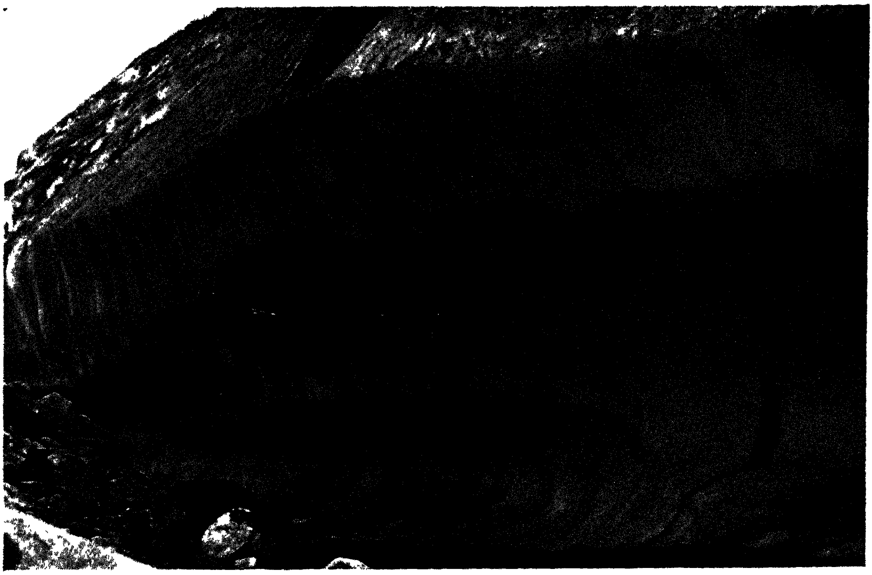


Fig. 27—Melt flutes on under side of overhanging ice face about 12 feet high, undercut at base by small stream. Note the broadly concave cross section of the flutes and the slightly rounded intervening ridges. Flutes are seldom more than a few inches deep and are 1 to 4 feet long and one-half to one-third as wide, with the long axis directly downslope, discordant with the banded structure of the glacier. Greater elongation and symmetry are characteristic of steeper slopes. On surfaces of gentle inclination flutes are short, and on nearly horizontal ceilings of caverns and arches roughly symmetrical scallops develop.

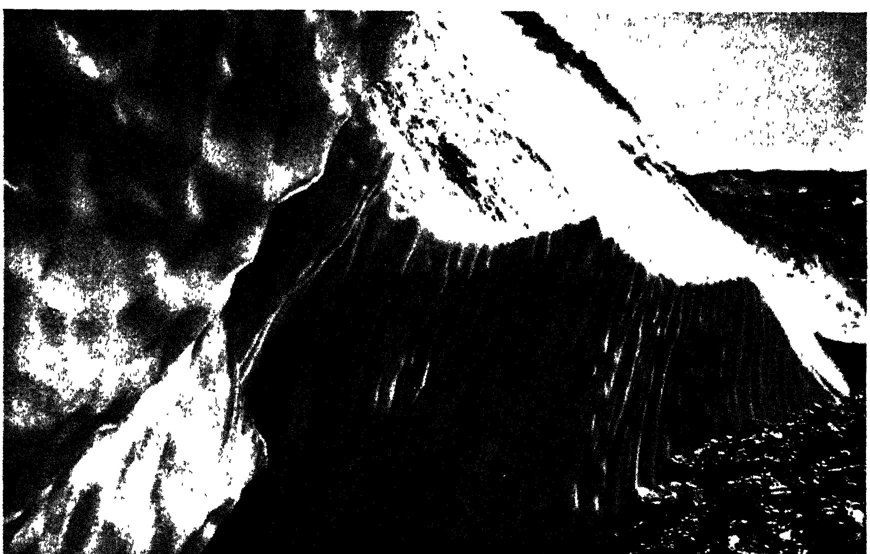


Fig. 28—Contrast between unfluted ice face exposed to direct sun (top center), scalloped face exposed to limited sun (left), and fluted face largely shaded (bottom center). Scallops, characteristic of nearly horizontal ice faces, develop on slopes as steep as this only when little meltwater is received from above.

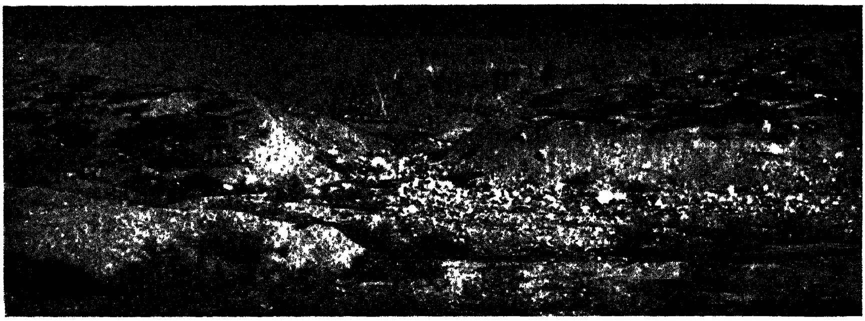


FIG. 29—Abandoned spillway channel cut across lateral moraine of Wolf Creek Glacier by a stream from the ice.

FIG. 30—Left margin of upper Wolf Creek Glacier showing how a lateral moraine is built as an apron of debris dumped from the ice.

FIG. 31—View northward down left bank of Wolf Creek Glacier above the bend showing abandoned lateral moraine and a marginal stream at left flowing between moraine and valley wall. Location is about one mile below Figure 30, where an outer lateral moraine ridge is still being built.

following ways: (1) by taluslike accumulation of detritus, particularly of large blocks that roll and fall from the ice; (2) by the building of small alluvial cones at the mouths of superglacial and englacial streams leaving the ice; (3) by flow of slimy, bouldery mud derived from debris upon and within the glacier; and (4) by accumulation of material, largely silt, in marginal ponds. These various modes of accumulation are not mutually exclusive. Their interaction and the entombment of large blocks of ice contribute much to the inhomogeneity of the moraine.

Such debris-apron lateral moraines are being built up in a mile-long stretch along Wolf Creek Glacier where it passes from an active to an inactive state. Necessary conditions are a good-sized fosse between the glacier and the valley wall, a nearly vertical wall of ice 50 to 150 feet high, a large amount of rock debris in and on the ice, and a not too powerful marginal stream. Down-valley the ice has shrunk back from the principal morainal ridge and is no longer able to supply debris to it (Fig. 31), though it may be building a lower subsidiary ridge. Farther up the valley the ice presses firmly against the valley walls and receives debris from them. The zone in which lateral moraines are built migrates slowly up-valley as the receding hemicycle advances. A continuous lateral-moraine ridge is therefore progressively younger up-valley. The difference in age between the upper and lower parts of the youngest lateral-moraine ridge along Wolf Creek Glacier is estimated at a hundred years.

If the marginal stream is large, it will either modify the lateral moraine, forming moraine terraces, or completely destroy it. In the latter case the material is deposited on the bed of the stream, to become kame terraces when the ice melts. Examples of these, 50 to 100 feet wide and a mile or two long, are numerous on the north wall of Wolf Creek Glacier below the bend, and a particularly striking succession of parallel terraces has been formed just below the mouth of the North Fork River.

Where a protective fosse between the valley wall and the glacier is lacking, rills running down the valley wall greatly modify the moraine in a relatively short time. On the steep north wall of Wolf Creek Valley, where this condition obtains, moraines estimated to be a hundred years old have been much altered. It is not surprising, therefore, that lateral moraines attributable to glaciers of Wisconsin or earlier age are hard to find in steep-walled valleys.

Marginal Streams

Marginal streams are fed by direct melting of the adjacent ice walls, by superglacial and englacial streams, and by drainage from tributary canyons

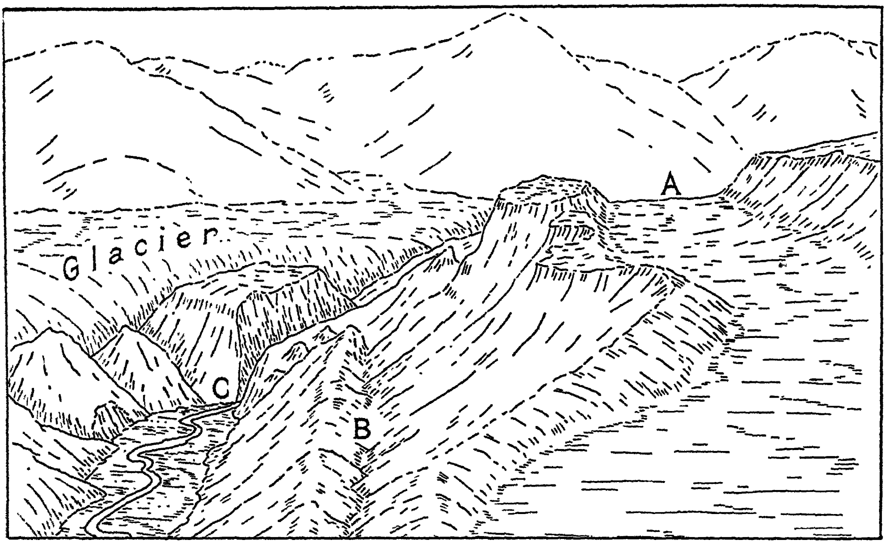


FIG. 32—Left bank of lower North Fork Glacier showing three marginal channels, A, B, C, entrenched in bedrock of valley wall. Sketched from a photograph.

and the valley walls. Their length is usually not great, for they soon enter englacial channels. In this area, where they are an almost universal accompaniment of the retreating or stagnating parts of a glacier, they flow in the following positions: (1) between the glacier and the valley wall; (2) between the glacier and its lateral moraine; (3) wholly within the lateral moraine; (4) between the moraine and the valley wall; or (5) in a channel entrenched in the valley wall. A stream may be confined wholly to one of these positions, or it may occupy different types of channel in different parts of its course. The commonest position along Wolf Creek is between the lateral moraine and the valley wall (Fig. 31).

The efficiency of large marginal streams as agents of transportation has already been mentioned. Their reworking of material dumped from the ice can prevent the formation of lateral moraines and produce moraine terraces and kame terraces. Proof of the erosional power of these streams is afforded by the abandoned bedrock channels entrenched in the valley walls. These are 20 to 150 feet deep, narrow, steep-walled, and partly choked with large boulders (Fig. 32). Some are short, aligned gulches crossing successive spurs between tributary valleys; others are clearly cutoff loops of entrenched meanders left hanging at both ends. Longer and straighter bedrock channels are continuous with remnants of narrow terraces representing the parts of the channel along which the glacier formed one wall. The position of some bedrock channels is determined by superimposition from a morainal cover,

FIG. 33—Marginal pond confined between glacier and its lateral moraine, left bank of upper Wolf Creek Glacier. July 6, 1941.

but others are located along the lines of overflow from ponded drainage. Abandoned marginal channels offer both man and beast an easy passage up a glacial valley.

MARGINAL LAKES

Marginal lakes occupy essentially the same positions as marginal streams (Fig. 33). Some lie in abandoned marginal-stream channels dammed by slides or alluvial cones, others in tributary valleys dammed by a trunk glacier. Except for the latter type, the lakes are neither large nor deep. They are quickly filled with fine silt brought by meltwater streams or with coarse debris received directly from the ice.

The sites of former lakes are identified principally by deposits of well-bedded silt; for most marginal lakes are too small and too short-lived to develop prominent shore-line features. An exception is offered by former North Fork Lake. During its last major advance, about 150 years ago, North Fork Glacier failed by two and a half miles to attain junction with Wolf Creek Glacier. The lateral wall of the trunk glacier effectively dammed the North Fork River, so that a lake a mile and a half long by three-eighths of a mile wide and at least 165 feet deep was formed. Its highest shore line is marked by a cliff and a wave-cut terrace 75 feet wide in till and 15 feet in bedrock. The North Fork River built a delta of cross-bedded sand and gravel, which gradually extended eastward over the bottom silts until the

entire upper half of the lake basin was delta-filled. In the rest of the basin an unknown thickness of silt collected. The well-developed shore-line features and extensive sedimentary fill suggest that North Fork Lake existed for a number of years. The lack of shore lines at lower levels indicates that the dam disintegrated so rapidly that pauses in the fall of water level were of short duration. Twenty-year-old scrub willows growing on parts of the abandoned lake bottom give the minimum date for the lake's disappearance. Since that time the North Fork River has removed a large part of the silt and much of the delta. Pauses in the stream's downcutting are indicated by terraces 5, 20, and 38 feet above the present stream level.

AN ECONOMIC SURVEY OF THE WESTERN PROVINCE OF LIBERIA

EARL PARKER HANSON

IN November, 1944, an economic mission under the direction of the writer was sent to Liberia by the Foreign Economic Administration at the request of the Liberian government. Our general assignment—to study the possible development of Liberia "with the help of the United States and for the mutual benefit of both countries"—included survey work, a program of agricultural development, investigation of the possibilities for new industries, and a study of transportation, education, and public-health problems.[1] The work accomplished, although necessarily of a reconnaissance nature, sheds light on the changes at present taking place in the economic and social structure of the country and provides a needed foundation for more detailed studies. The mission was recalled in June, 1946, because of the termination of the Foreign Economic Administration, but it has recently been reorganized under the Department of State.

The increased American interest in Liberia that resulted in the wartime establishment there of an American military garrison (now withdrawn) is also reflected in other ventures. Among them are the maintenance of a large airport at Roberts Field, the construction by the United States Navy of a commercial seaport at Monrovia (on a reimbursable contract basis that imposes on Liberia the eventual repayment of costs), the maintenance of a health mission by the United States Public Health Service, and the projected completion of an automobile highway from Monrovia through the Central Province to the border of French Guinea. The recent granting to an American group of a concession for working the iron-ore deposits at Bomi Hill, in the Western Province some 40 miles north of Monrovia, is a further manifestation of the growing ties between the two countries.

It is not possible in a single article to give an adequate picture of the mission's activities throughout Liberia (Fig. 1), and the present discussion is therefore limited in general to the Western Province. This region is to a large extent representative of conditions in the country as a whole, and the prospective mining activities at Bomi Hill have focused attention on the province,

[1] The American technicians who carried the work forward, with the cooperation of Liberian specialists, were H. F. Benton, civil engineer; F. E. Pinder, agriculturist; J. R. Ross, forest-products specialist; and Dr. George W. Harley, general consultant and adviser on small industries. H. R. Van Wagenon, mining engineer, and Donald Smythe, geologist, gave their services briefly on mineralogical and geological problems.

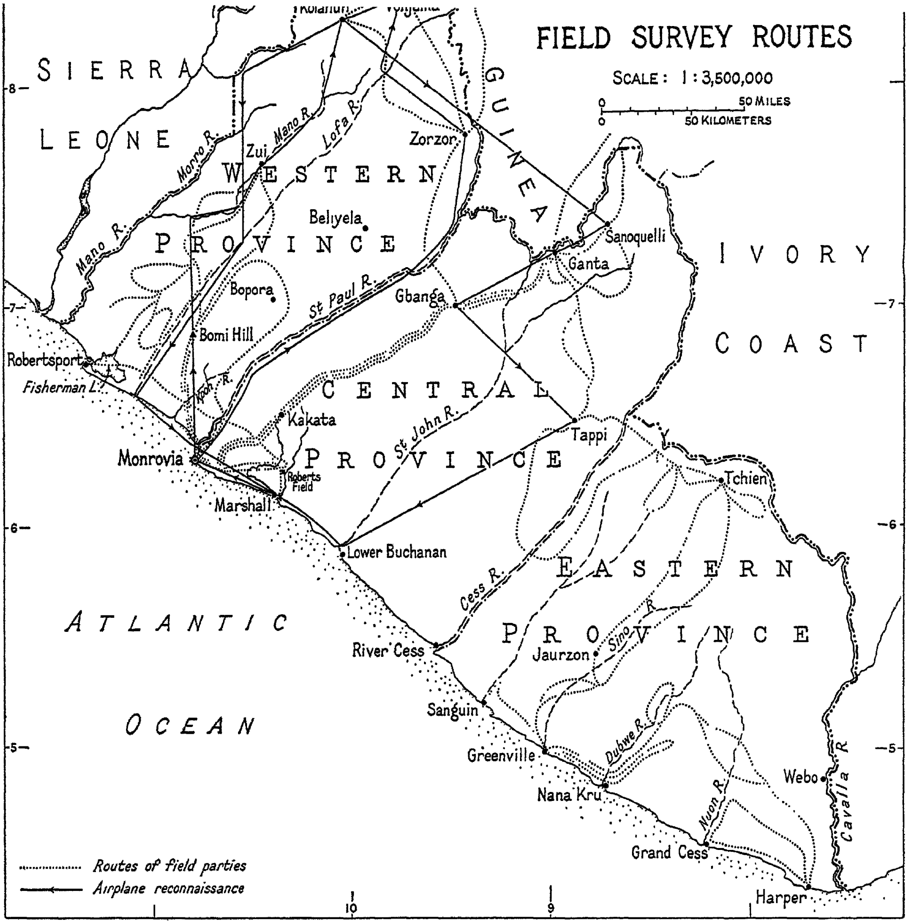
particularly as regards labor, food supply, and transportation facilities. Mining operations will demand the construction of a railroad from the mines to the port at Monrovia. At present it is not known whether this will be purely a mining railroad, with limited utility and range, or whether it will be extended through international effort to French Guinea, in accordance with a plan first proposed by the French in 1928.

General Background

Liberia, although established as a republic in 1847, has long possessed some of the characteristics of a colonial empire. About thirty years ago the aboriginal tribes of the interior were "reduced," and they have since been ruled by the Americo-Liberians under a colonial system roughly conforming to the British pattern of "elected" native chiefs answerable to provincial and district commissioners appointed by the government. The Americo-Liberians, descendants of the freed American slaves who first began to colonize the country in 1821, number only some 15,000 and are concentrated in the towns and on the plantations of the coastal strip. The aborigines, of whom there are about a million and a half, are mainly scattered in villages throughout the hinterland. The class line has always been tightly drawn, the prevalent attitude among Americo-Liberians being that the aborigines should be "kept in their place," where their primary function consists of contributing hut taxes, foodstuffs, and cheap labor.

However, the inauguration in January, 1944, of President W. V. S. Tubman, whose term runs until 1952, marked the beginning of reforms so drastic as to amount almost to social revolution. For either humanitarian or economic reasons, or perhaps for both, President Tubman has initiated a program leading to eventual "equality" of aborigines and Americo-Liberians, and thus, by implication, to the abolition of Liberia's colonial system. The aims of this program are to absorb the aborigines fully into national life (legislation has been put through giving them the right to vote and representation in the national legislature) and to weld the population into one homogeneous citizenry with equal rights, social status, and economic opportunity. These reforms, which should eventually increase materially the purchasing and taxpaying power of some 99 per cent of the population, augur well for the projected economic development and modernization of the country. As might be expected, they have also created internal political difficulties. Other nations watch with interest the beginnings of this voluntary abolition of one of Africa's colonial regimes.

Liberia's precarious economic situation is indicated by the graph of im-


FIELD SURVEY ROUTES
SCALE: 1 : 3,500,000
0 50 MILES
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SIERRA LEONE
GUINEA
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CENTRAL PROVINCE
EASTERN PROVINCE
ATLANTIC OCEAN
Kolahun
Vonjama
Zui
Zorzor
Beliyela
Bopora
Bomi Hill
Robertsport
Fisherman L.
Monrovia
Kakata
Roberts Field
Marshall
Gbanga
Ganta
Sanoquelli
Tappi
Tchien
Lower Buchanan
River Cess
Jaurzon
Sanguin
Greenville
Nana Kru
Grand Cess
Webo
Harper
Mano R.
Morro R.
Lofa R.
St Paul R.
Kpoh R.
St John R.
Cess R.
Sino R.
Dubwe R.
Nuon R.
Cavalla R.
8
7
6
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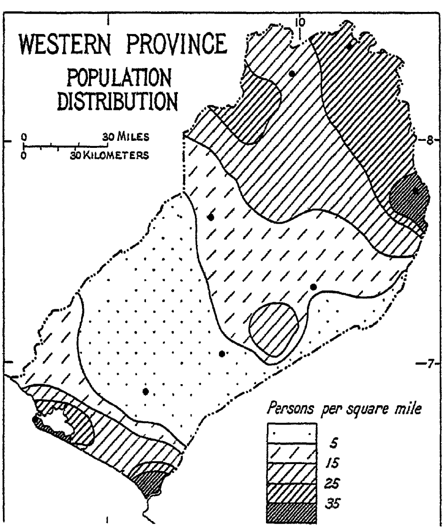
Routes of field parties
Airplane reconnaissance

FIG. 1


WESTERN PROVINCE
POPULATION DISTRIBUTION
0 30 MILES
0 30 KILOMETERS
10
8
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Persons per square mile
5
15
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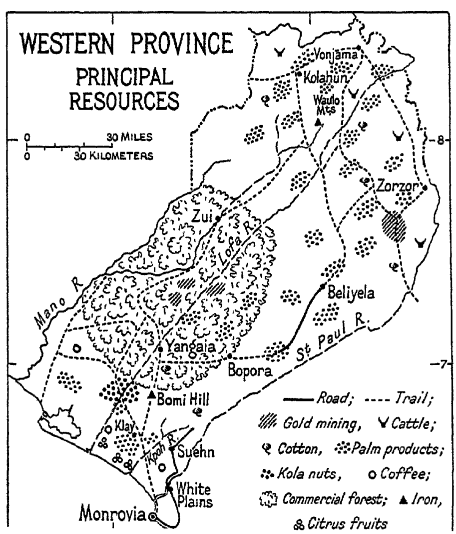
WESTERN PROVINCE
PRINCIPAL RESOURCES
0 30 MILES
0 30 KILOMETERS
Vonjama
Kolahun
Waulo Mts
Zorzor
Zui
Lofa R.
Mano R.
Beliyela
St Paul R.
Yangaia
Bopora
Bomi Hill
Klay
Kpoh R.
Suehn
White Plains
Monrovia
8
7
Road; Trail;
Gold mining, Cattle;
Cotton, Palm products;
Kola nuts, Coffee;
Commercial forest; Iron,
Citrus fruits

IG. 4—Business section of Monrovia. The railroad bridge was built by the U.S. Navy to facilitate the transport of rock to the water which may be seen, still in process of construction, in the background.

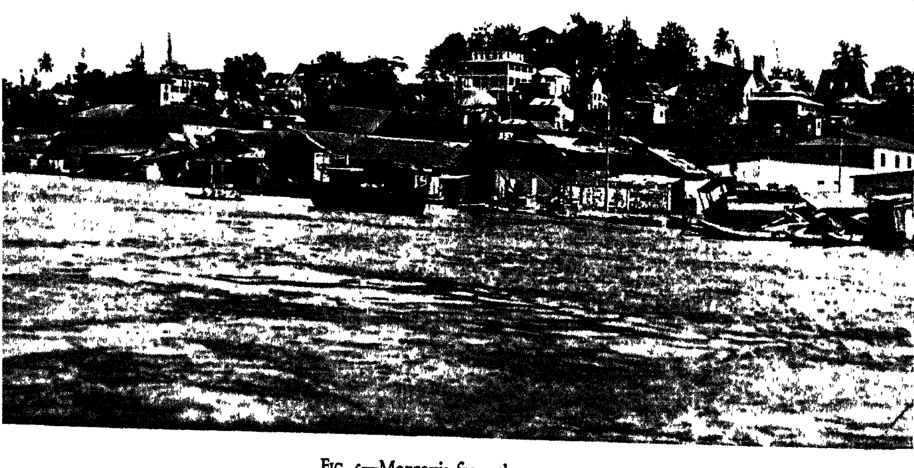

FIG. 5—Monrovia from the sea.

ports and exports (Fig. 7). In 1944, the latest year for which statistics are available,[2] the value of exports reached the unprecedented total of $10,306,308. But rubber, exported exclusively by the absentee Firestone Plantations Company, accounted for about 90 per cent, or $9,418,282. Gold, a government monopoly, made up nearly 8 per cent of the exports, with a total value of $817,474. Purely local products such as piassava (palm fiber) and palm kernels made up less than 1 per cent, with a value of only $70,552. One of the most important objectives of the American economic mission was to find ways of increasing this last figure as much and as soon as possible in order to ensure a better balance within the shaky economic structure.

The Western Province

The Western Province is roughly rectangular in shape, with a long axis of some 150 miles from the coast to the border of French Guinea and a transverse axis of about 75 miles from the St. Paul River to the Sierra Leone boundary. In general, the rivers flow southwest, roughly parallel to one another and to the borders of the province. The character of the topography may be inferred from the map of physiographic regions (Fig. 6), which, although necessarily generalized, gives a representative picture of the steadily increasing elevation inland from the coast.

Marked climatic differences exist between the coastal plain and the far interior. Seasons are distinct on the coast. The dry season extends from early December to mid-April or early May, and a secondary "dry" period, known locally as the "middle drys," appears in late July, when for several weeks the normally heavy precipitation of the rainy season is greatly diminished. The rains of the wet season are torrential and steady, and flooded roads and swollen streams impede transportation. Only limited climatic records are available, but these indicate that the mean annual rainfall is more than 170 inches on the coast; as much as 8 inches may fall in a single 24-hour period.[3] Temperatures are, on the whole, not extreme, the monthly mean ranging from about 76° F. in the cooler months to a little more than 80° F. in March, the warmest month.[4] The so-called "enervating" effect of such a climate, with high humidity and small variations in temperature, is open to debate. The writer has found the Liberian coastal climate—and, in fact, similar climates else-

[2] These figures were furnished by Mr. C. T. Pilot of the staff of the financial adviser to the Liberian government.

[3] Emory Ross: The Climate of Liberia and Its Effect on Man, *Geogr. Rev.*, Vol. 7, 1919, pp. 387–402; reference on pp. 390 and 392.

[4] *Ibid.*, p. 388.

where—pleasant and in no way enervating as long as there is no question of food deficiencies and one continues active mentally and physically. In the interior, conditions moderate with increasing elevation and distance from the coast. Temperatures are considerably lower, especially at night; the humidity is less; the rainfall near the French Guinea border is about half that of the coastal areas.[5]

Population

No census has ever been taken in Liberia, and there are no official estimates of the population by provinces. However, government figures indicate a total of 29,359 huts on which taxes are collected in the Western Province exclusive of the coastal strip. At an estimated average of six persons to a hut the population of the hinterland would be about 176,150.[6]

The distribution of the population as determined from tax data and aerial and ground reconnaissance is shown in Figure 2. Densities are heaviest (reaching 35 persons to a square mile) along the coast, where Americo-Liberian influence predominates, and along the French Guinea frontier. The St. Paul Valley is sparsely populated except for the lower end, where navigability of the stream plus rich soils early led the Americo-Liberians to establish a number of communities. It should be noted that the belt of very sparse population (0-5 inhabitants to a square mile) includes the Bomi Hill area.

The aborigines, who make up the great majority of the population of the province, belong to a number of tribes (Vai, Mendi, Gola, Mandingo, Gissi, Gbunde, Buzi, Kpwessi, and Gbande), differing in language and details of culture. They have in common, however, a traditional tribal way of life, which has been greatly modified within the past 25 years and may now enter a period of abrupt transition as a result of the reforms recently instituted by President Tubman. Powerful secret societies, such as the Poro[7] and the Sande, have long dominated the lives of the aborigines, beginning with the education of the young. After a century of Liberia's existence as a republic, the conflict between the tribal way of life and the Liberian national life is still strong; some of the aboriginal leaders even today regard the Americo-Liberians as intruders and refer to them in official councils simply as "Americans."

[5] As reported by Dr. Harley after a residence of more than 20 years at Ganta Mission, in the interior of the Central Province.

[6] It seems probable from general observations and reconnaissance surveys that these figures are very low and that the total population may well be near 400,000.

[7] See G. W. Harley: Notes on the Poro in Liberia, *Papers Peabody Museum of Amer. Archaeol. and Ethnol., Harvard Univ.*, Vol. 19, No. 2, 1941.

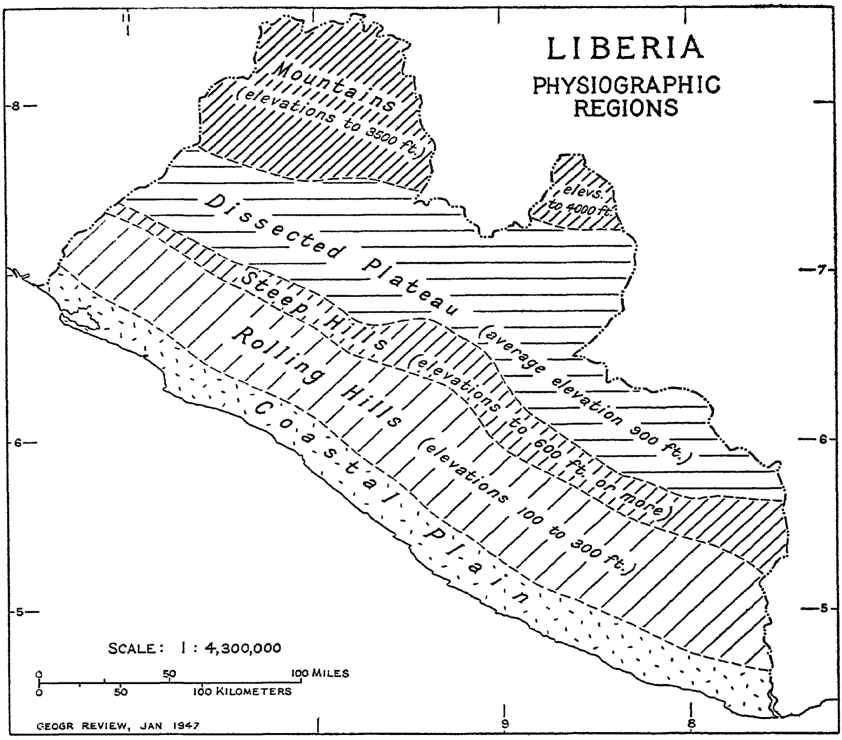

FIG. 6

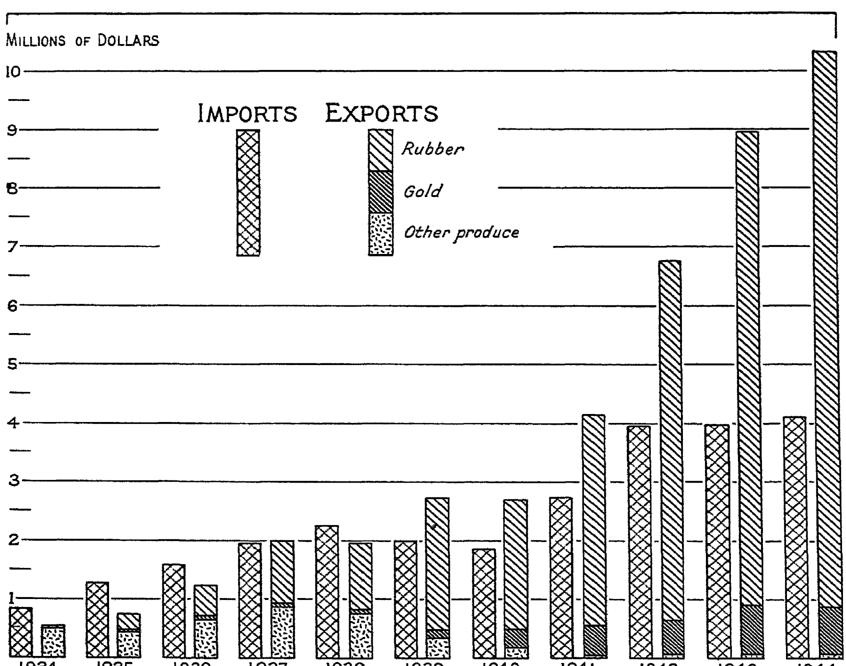

FIG. 7—Liberia's imports and exports, 1934–1944.

Natural Resources

Figure 3 shows the principal resources of the Western Province as known today. The iron-ore deposit at Bomi Hill is the only mineral deposit in Liberia that has been explored by qualified technicians; it was first examined in 1938–1939 by a Dutch group, later by representatives of an American

Fig. 8—A ceremonial parade of the Sande Society.

corporation, and finally, in 1943–1944, by the United States Geological Survey. The reports of the investigations have not yet been published, but they are known to recommend further technical exploration, though at the same time indicating that the deposit is of suitable quantity and quality to warrant the projected extraction of the ore and shipment to the United States for smelting. American interest in the deposit is heightened by the fact that intensified mining operations in the United States during the war years have seriously depleted our reserves of high-grade iron ores. Reports of other iron deposits, reputedly even larger and better, come from various parts of Liberia, and, in the Western Province, from the vicinity of the Waulo Mountains, near Kolahun. However, in part because of their remoteness, and in part because of Liberia's past policy of "isolationism," under which foreign technicians were not welcomed in the interior, these deposits have never been even superficially examined by experts.

Near Zorzor and in the heart of the Gola Forest, in the Takporima-

Gondorja-Yangaia area, there are extensive gold washings. Between 300 and 400 men are employed in the Gola workings, but unfortunately the archaic methods result in considerable loss of the gold, perhaps as much as 60 per cent. Our preliminary studies reveal that this gold area, although not the richest in Liberia, could be made to yield enormous profits by the employ-

FIG. 9—Pounding palm kernels for the extraction of oil.

ment of modern mining techniques. There are indications that some of the gravels might yield as high as $30 a ton.

Gold is particularly important at present as a means of providing immediate revenue to be used for the government's ambitious program of development. Even minor improvements in technique would result in increased financial returns, and the value of the commodity is such that transportation by the prevailing expensive headload method is economically feasible.

Persistent reports of deposits of both industrial and gem diamonds come out of the Western Province, but those who claim to have knowledge of the matter are unwilling to specify the locations. The British some years ago requested exclusive rights to diamond mining in Liberia but were refused on the supposition that they were more interested in keeping Liberian diamonds off the market than in mining them.

From time to time samples of corundum, manganese, chromite, bauxite,

cassiterite, lead, and copper have been brought from the hinterland (whether from the Western Province or the other provinces is not known). There is obviously much work to be done by mineralogists of future economic missions.

Commercial clays are found in abundance, especially along the lower St. Paul River and in parts of the interior. Tests conducted by our mission show them to be suitable for a variety of manufactures, ranging from bricks and tiles to ceramics. The clays therefore offer a promising basis for the development of a number of local industries.

Although a large part of the Western Province is forested, Figure 3 shows only the area where our investigations revealed stands of sufficient density to warrant future large-scale commercial operations. Estimates of the commercially valuable stands within this area range from 900 to 2500 square miles. Densities range from 14,000 to 47,000 fbm (feet board measure) to an acre, with a total of 25 billion fbm for the 900 square miles of the so-called "Zui Forest," which extends southward from the town of Zui.[8]

As elsewhere in the tropics, the forest is composed of mixed stands of many kinds of trees, differing widely in size, hardness of wood, and commercial suitability. Detailed studies, including botanical identification and laboratory timber tests, were made by J. Proctor Cooper, 3d, on the Firestone Plantations, some seventy miles to the southeast.[9] With a few exceptions, these studies are applicable to the Gola Forest area.

In view of the present world lumber shortage, the potential importance of the Gola Forest and other rich Liberian timber areas is obvious. The prospective construction of a railroad into the adjacent Bomi Hill area and the stimulated economic development of the country as a whole give reason for hope that the Gola Forest resources will be commercially utilized before too long. Logging of all commercially valuable trees in a given area and subsequent sorting of timber would be greatly preferable to the expensive but widespread method of tropical lumbering in which a single species, such as mahogany, is logged over a considerable area. There has never been any commercial lumbering in Liberia, except for laborious hand operations involving pitsawing. All lumber used in the construction of the new port at Monrovia has had to be imported, largely from the United States, in part from the Gold Coast.

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[8] Various parts of the general forest area are known as the Gola, Zui, and Loffa Forests. Since the first is the most widely known, the entire area is here called the Gola Forest.

[9] J. P. Cooper, 3d, and S. J. Record: The Evergreen Forests of Liberia, *Yale Univ. School of Forestry Bull. No. 31*, 1931.

The species of palm from which palm kernels and piassava are obtained are scattered in virtually unlimited numbers throughout the low and swampy areas of the province. Before the war, both commodities were exported by the Germans and the Dutch from areas near the coast to which transportation by headloading was commercially feasible. A profitable trade with the United States would involve solution of several problems: availability of labor for gathering and transporting the wild products; improvement of transportation facilities from the interior to the coast and along the coast to the port at Monrovia; and processing, sorting, and grading to meet the relatively high standard demanded by American importers.

Kola nuts are found in various parts of the province, though as a rule they are used only locally. There is, however, a known trade in the nuts from the far interior into French Guinea, whence some of them find their way by devious routes to the United States. There seems a good chance that a trade in kola nuts could eventually be built up directly between Liberia and this country.

Agriculture

Most of the agriculture in Liberia is carried on by the aborigines, using the traditional slash-and-burn method that is wasteful of manpower, timber resources, and soil fertility and yet results in relatively low yields and the frequent shifting of settlements. Rice is Liberia's staple food crop, brought from the hinterland to the more populous areas such as Monrovia and the Firestone Plantations. However, because of the primitive agricultural and transportation methods, the supply thus received is far less than the demand. Firestone annually imports from abroad thousands of tons of rice for its workers, and yearly famine or near famine is almost taken for granted in Monrovia. It is apparent that any future large-scale development, such as that projected for Bomi Hill, must face at the outset the dual problem of inadequate food supply and inadequate transportation.

In general, the same crops are grown throughout the Western Province. Rice, cassava, eddoes, bananas, and yams predominate. Citrus fruits, especially grapefruit, are grown near the coast, notably in the vicinity of Klay. The fruit finds a ready market in Monrovia and has even been exported in small quantities to England. At present, as with other crops, considerations of transport limit cultivation. Sugar cane is also grown in the coastal area, most of it being used in the manufacture of the raw trade rum called cane juice. Coffee was cultivated for export in considerable quantities before the war, especially in the Kpoh Valley area. The Germans were the leading ex-

porters, and the trade has now almost ceased. Large coffee plantations have been abandoned and are growing back to bush; whether or not they can be restored and the trade revived is a widely debated question.

Peanuts and cotton are raised in the area between Zorzor and Kolahun. Cacao is at present found only in negligible amounts in the Western Province, but there seems to be no reason why cultivation should not be expanded, particularly along or near the coast. In fact, cacao offers perhaps the best possibility for a lucrative trade with the United States, which now obtains some 60 per cent of its total cacao imports from the Gold Coast. Further, cacao possesses one great advantage over many tropical agricultural commodities: it is well suited to individual cultivation by small, independent landowners and does not require large-scale, corporation-owned plantations.

In the far interior there are some cattle and a few horses and donkeys, culturally "borrowed" from adjoining French Guinea, but in the rest of the province the use of pack and draft animals is unknown; domestic animals are confined to a few scrawny chickens and some goats.

To test the reaction of the aborigines to new agricultural ideas, technicians of our mission, with the cooperation of agriculturists of the Liberian government, carried out a demonstration program in some twenty villages in the Kpoh Valley. Somewhat to our surprise, we found the people adaptable to the point of enthusiasm. They began to plant crops in the swampy areas in the dry season and in the uplands in the wet season; they readily grasped the principles of fertilization and of the use of compost heaps; they cultivated many plants entirely strange to them, ranging from Egyptian wheat to cabbages and corn, sold some of the produce in Monrovia, and ate the rest; they learned to use insecticides to combat insect pests. Even more interesting was the eagerness with which they took to the four donkeys that we introduced. They had never seen donkeys, but they immediately learned to ride them and were equally quick to take advantage of the—to them—astonishing fact that one donkey can carry as much as four or five human bearers. They successfully planted forage crops for the donkeys, and they set out thousands of grapefruit seedlings because the improved transportation would permit the sale of the fruit in Monrovia. For the first time in years, the people of these villages had their money ready when the collectors came for the hut taxes. News of the program spread rapidly, and requests for similar demonstrations came from many parts of the country. The success of the program speaks well for the adaptability of Liberia's aborigines and is an encouraging signpost on the road to rapid agricultural development.

FIG. 10

FIG. 11

FIG. 12

FIG. 13

FIG. 14

FIG. 15

FIG. 10—Mr. F. E. Pinder (third from left) demonstrating to a group of farmers the inoculation of a hog against cholera.
FIG. 11—A cleared field ready for burning.
FIG. 12—Donkeys introduced by the F.E.A. Mission on a typical trail in the interior.
FIG. 13—Hand-powered surfboat of the type used in coastal shipping.
FIG. 14—Americo-Liberian dwelling, Robertsport.
FIG. 15—Native dwellings, village of Wlakor.

Transportation

In spite of the obvious need for the development of transportation throughout the hinterland, coastwise shipping is Liberia's most urgent single transportation problem today. In fact, improvement of shipping along the coast, where the business houses are located and where the commercial-minded Americo-Liberians live, would result in markedly increased revenues with which to finance hinterland development. The relative and actual decline of exports of commodities other than rubber and gold (Fig. 7) is due almost entirely to wartime shipping difficulties.

Before the war, a number of European steamers stopped periodically at various Liberian ports, beginning in the north at Robertsport, to pick up and discharge cargoes. This service was interrupted by the war, with the result that most of the ports, with the exception of Monrovia and Marshall (from which Firestone's rubber is shipped), were left virtually stranded. Although a certain amount of the prewar shipping may now be expected to resume, the modern docking facilities of the new port at Monrovia will probably tend to discourage the expensive anchorage in the open roadsteads of the smaller ports. In that case, the need for improvement of coastwise shipping will be all the more urgent.

At present all of Liberia's coastal shipping is carried on by hand-operated surfboats, each of which has a capacity of some 2½ tons and requires a crew of 10 to 12 men. The 50-mile trip from Robertsport to Monrovia takes from 12 to 48 hours, according to wind and weather. Losses are high, both from theft and from natural dangers. The over-all cost of shipping by surfboat between these two ports, covering operation, repair, and replacement of boats and maintenance of a labor force, is estimated at 13 to 15 dollars a ton.

In the interior of the Western Province goods are moved almost entirely by human carriers with headloads. A network of trails, which have never been accurately shown on any map,[10] covers the province. In recent years the main trails have been widened to permit travel by hammock and are in surprisingly good condition. In the Zorzor-Vonjama area several hundreds of miles of trails could be used even now for automobile travel, except for the bridging of streams. Additional hundreds of miles of main trails could be graded, widened, and surfaced (the laterite found throughout the country is excellent material for road surfacing) with a relatively small expenditure of money and labor, though again the construction of numerous bridges would be necessary.

[10] These trails have, however, been well described by G. W. Harley: Roads and Trails in Liberia, *Geogr. Rev.*, Vol. 29, 1939, pp. 447-460.

The main road in the Central Province, from Monrovia to the border of French Guinea, was begun some 25 years ago when the Firestone Plantations were established in Liberia. Construction has been carried forward at various times, and a large section was recently finished by the United States Army. In the Western Province an automobile road has been built from White Plains to a point a few miles beyond Suehn, and another section extends from Beliyela south for some 25 miles; construction of the link to connect the two is now in progress.

In their preoccupation with modernization and development the Americo-Liberians are filled with enthusiasm for the construction of automobile roads, but few of them realize the danger of overextending the road system at the present time. Except on the Firestone Plantations, there are virtually no automobile mechanics in the country, no repair shops, very few spare parts, and few gasoline supplies; money, labor, and equipment for the maintenance of highways are generally lacking. The construction of even a few miles of automobile road immediately results in a rush of land buying, which in turn leads to the introduction of new methods and cultures that are dependent on reliable transportation. Until the means for maintaining not only the roads but also the cars and trucks that run on them are provided, there is danger that the areas tapped by new roads may some day be left stranded through the breakdown of the modern transportation on which they rely.

It would be a relatively simple matter to introduce donkeys on the trails, as our demonstration proved, and thus release thousands of men for more useful work. One donkey can carry the loads of four or five human carriers and travel a greater distance in a day, and one man can drive twelve donkeys or more. There would, of course, be problems involved in such an innovation; for example, the opposition of the small but powerful group of Americo-Liberians that desires to keep the aborigines in a subordinate position, the need for planting forage crops, the necessity of medical control to prevent the spread of sleeping sickness by the animals, the lack of bridges across the numerous watercourses. But none of these difficulties are insuperable, and there is pressing need for the introduction of pack and draft animals, both for the purpose of effecting immediate improvement in transportation and as adjuncts to mechanized transport as the road system is extended.

Since the rivers of the province flow transversely over sharp changes in elevation, river transport is not generally used, except near the mouths of the main streams and on isolated inland stretches serving purely local needs.

On the St. Paul River, however, from White Plains to the mouth, a distance of about 15 miles, improvement in power transportation is not only feasible but highly desirable in view of the relatively dense settlement, the agricultural development, and the possibilities for the building up of local industries based on the abundant deposits of commercial clays.

Commerce

The Dutch East African Company has long been the leading trading house in Robertsport, the only commercial seaport in the Western Province.

Table I—Shipments from Robertsport by the Dutch East African Company

YEAR	PIASSAVA (56-lb. bundles)	COFFEE (150-lb. bags)	CACAO (50-lb. bags)	PALM KERNELS (169-lb. bags)	GOLD (Ounces)
1934-35	6,722	600	43	1,938	....
1935-36	9,697	953	20	1,824	....
1936-37	17,790	2,462	8	5,027	....
1937-38	17,860	723	12	3,071	....
1938 39	17,085	1,114	24	3,078	....
1939-40	10,940	145	15	928	....
1940-41	8,028	....	....	....	90.17
1941-42	7,725	....	....	....	35.14
1942-43	283	....	....	....	....
1943-44	950	....	....	....	....

At one time this firm had eight inland contractors and its operations extended some 25 miles in various directions, or to the economic limit of headload transportation. Table I shows not only the present plight of the firm but Robertsport's decline as well.

During the war the maintenance of the Pan American Airways base and a Royal Air Force base at Fisherman Lake brought a certain amount of money and activity to the Robertsport area. Both bases have now been abandoned, and until European steamship service is resumed or coastwise shipping facilities have been improved, virtually the only sources of income for the once-important Robertsport area are the government pay rolls, the Episcopal mission, and a brisk smuggling trade across the Sierra Leone border.

In the interior, trade, as an integral part of Liberia's national commerce, can hardly be said to exist. A few goods filter in and are sold at extremely high prices to those who have money obtained from the Firestone pay rolls, from gold mining, or, once again, from the widespread smuggling trade with Sierra Leone and French Guinea. This illicit trade with the more highly commercialized neighboring colonial regions is an important factor in the

country's economic structure, pouring revenue into the national treasury through the payment of hut taxes if not through the payment of customs duties. The current annual budget of two million dollars could hardly be met solely from the direct and indirect proceeds of a 10-million-dollar export trade. Also, the smuggling accounts in part for the relatively high density of population in the frontier areas. Except for occasional drastic legal action in the case of gold, the Liberian government does little or nothing about the smuggling, partly because the trade does have financial importance and partly because of the physical impossibility of patrolling the borders. However, one of the reasons for the proposal that the projected railroad from French Guinea pass through the Zorzor-Kolahun area is the desirability of channeling at least a part of that area's substantial trade through the new port at Monrovia.

NOTES ON THE PLEISTOCENE GLACIATION OF THE SOUTH CHINESE-TIBETAN BORDERLAND*

J. HANSON-LOWE

IMMEDIATELY to the west of the mighty Ta Hsüeh Shan mountain complex (the Great Snowy Range), which forms the western boundary of the Chinese province of Szechwan, lies a lofty plateau some 13,000 feet in average elevation. The southeastern part of this plateau, which I visited in 1936 and 1937, is the scene of the observations presented here (Fig. 1).[1] Although precise delimitation of the region is not possible, the western boundary may be said to lie at about 99° E. where the upper Yangtze follows an almost meridional course, with the relatively little-dissected plateau of central Tibet rising to the west. To the south the transitional zone leading to the much lower Yunnan plateau, at some 6500 feet, forms an approximate boundary. On the east lies the striking demarcation belt of the Ta Hsüeh Shan. The northern limit is less clear but may be taken as a zone passing roughly through Chamdo, Derge, Kantse, and Sungpan. This zone lacks the deep gorges characteristic of the trunk streams in our region and is itself delimited to the north by the much higher grasslands of the *tsauti*.

Field observations in the region indicate clearly that glaciation was active during the Pleistocene at levels considerably lower than at present. A knowledge of such glacial activity has a direct bearing on many important questions, including local climatic conditions during the Pleistocene and vertical movements of the earth's crust in this part of Asia since the end of the Tertiary.

It should be emphasized, however, that a detailed examination of the glacial morphology was not undertaken, largely because my companion in 1937 unfortunately suffered en route from an obscure and obstinate fever, which made necessary a rapid return to Kangting (Tatsienlu). Moreover, conditions were too unsettled to permit us to camp at any but recognized

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* An account of my journey in this region in 1937 is to be found in "A Journey along the Chinese-Tibetan Border," *Geogr. Journ.*, Vol. 95, 1940, pp. 357–367. A paper on the climatic observations, "Notes on the Climate of the South Chinese–Tibetan Borderland," appeared in the *Geographical Review*, Vol. 31, 1941, pp. 444–453. Professional and military duties have delayed until now the publication of the accompanying notes on glaciation. [Because of difficulties of communication the author has been unable to read proof of this article—EDIT. NOTE.]

[1] There are virtually no detailed maps of this region, with the exception of the admirable geological atlas of Tan and Lee (H. C. Tan and C. Y. Lee: Atlas for the Geology of Szechuan Province and Eastern Sikang, *Memoirs Geol. Survey of China*, Ser. A, No. 15, 1935), which consists of a series of accurately mapped route traverses.

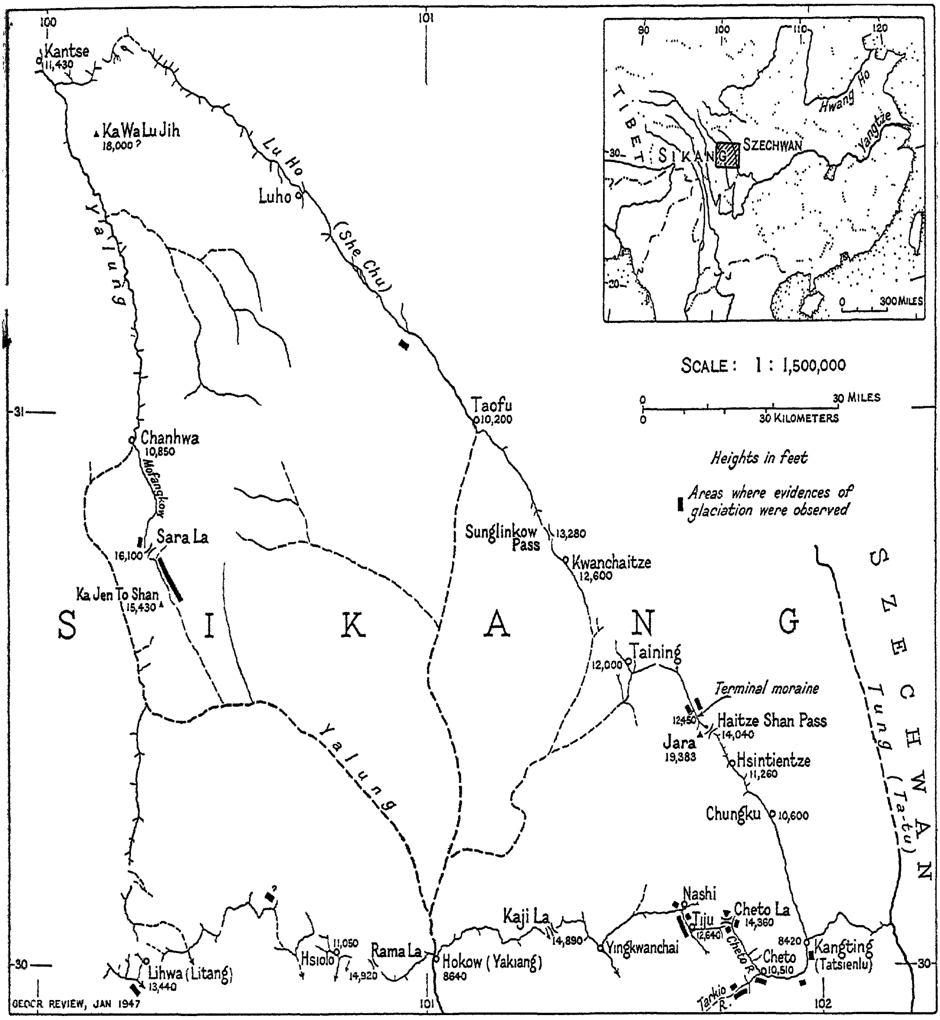

FIG. 1

stages, and even certain of these, such as Kwanchaitze, were too regularly the haunt of bandits to attract unarmed travelers. Nevertheless, many interesting observations were made, from which significant conclusions can be drawn.[2]

Character of the Landscape

Before the glacial morphology is discussed, certain general features of the region may be reviewed briefly. The greater part of the landscape

[2] I had the privilege of discussing my photographs of this region with my former professor, Dr. Henri Baulig, at The Hague in 1938, and with Professor C. A. Cotton at Wellington in 1939. Neither is responsible, however, for any of the opinions expressed here.

that I saw is modeled out of Jurassic sandstones, slates, and shales. Granite and gneiss occupy a relatively small, though important, area, and Permian limestones are even more limited in occurrence. The upland surface beveling these rocks is a peneplane, now uplifted and dissected. To the west, northwest, and north of the region examined the original(?) erosion surface is better preserved than here, but broad stretches of gently undulating upland were commonly seen. Dissection here is deep; the Yalung River, for example, flows some five or six thousand feet below the peneplane surface. In general, depth of valleys and dissection of the upland are more pronounced toward the south and southeast.

Partly because of the ease with which the Jurassic rocks disintegrate, many characteristic indicators of former glaciation, such as striated and polished rock surfaces, tend to be lacking. Moreover, in areas of marked petrological uniformity erratics are detectable only with great difficulty, if at all. Also, because the glaciation was not at all intense, terminal moraines were, with one striking exception, not observed—were, indeed, hardly to be expected. Thus the main evidence for past glaciation lies in the presence of glacially developed landforms such as corries (cirques) and trough-shaped valleys. Although hesitation must be expressed in classifying certain of the forms as corries, others so patently fall under this heading that there is no room for doubt as to their glacial origin.

Observations: Kangting to Yingkwanchai

The first unmistakable evidence of past glaciation was observed from a point about 2½ miles south of Kangting, at an elevation of some 10,000 feet on the left bank of the valley. Eastward across the valley corries were seen along the ridge on the horizon (Fig. 2), a few miles north-northwest of the Tatsienlu Glacier. Their elevation is not known, but it is probably about 13,000 feet.

On the south side of the valley opposite the hamlet of Cheto the bare, rocky summits had small, well-developed corries in granite-gneiss (Fig. 3). When viewed from an elevation of 13,300 feet some 5 miles farther west, their lower parts appeared to be only very slightly above the horizontal plane through the observation point.

Similar forms were seen southwest of Cheto, cut in the granite-gneiss high up on the right wall of the V-shaped Tarkio Valley (Fig. 8). A stiff climb was made up the rhododendron-covered scree slopes to examine a series of elongated, subparallel, steep-walled corries facing northwest and floored with cobbles and large boulders. They terminated on an average at

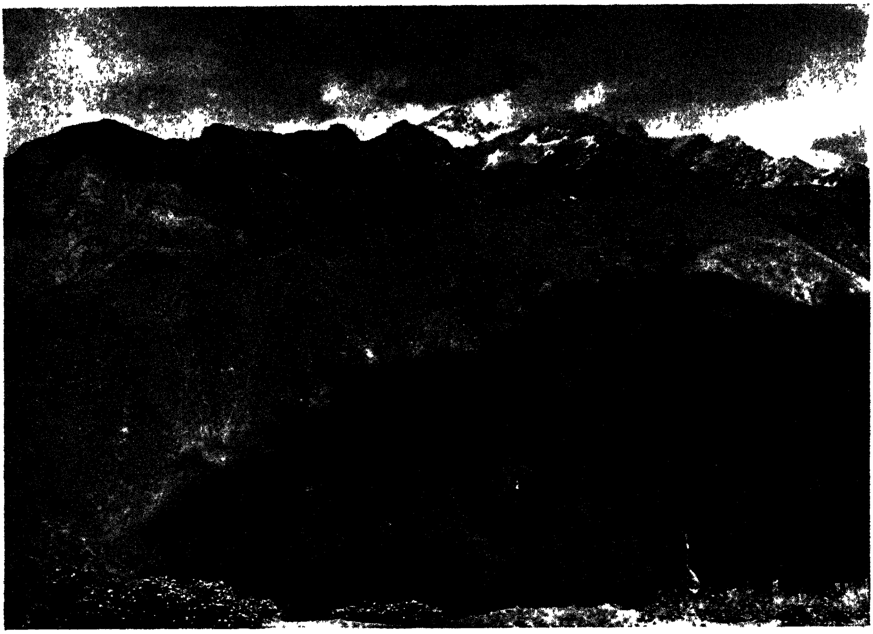

FIG. 2

FIG. 3

FIG 2—Corries north-northwest of Tatsienlu Glacier. The high peak in the background is Yiping Shan

FIG. 3—Corries south of Cheto hamlet.

13,360 feet, where there was a marked break in the slope of the corrie floor.

Continuing up the Cheto Shui (valley) from the hamlet of Cheto, we observed small corries high up on the south wall; it was not possible to see whether there were any on the north. At 13,300 feet the Cheto Shui lost its V-shaped cross profile. The side slopes became concave upward, and they

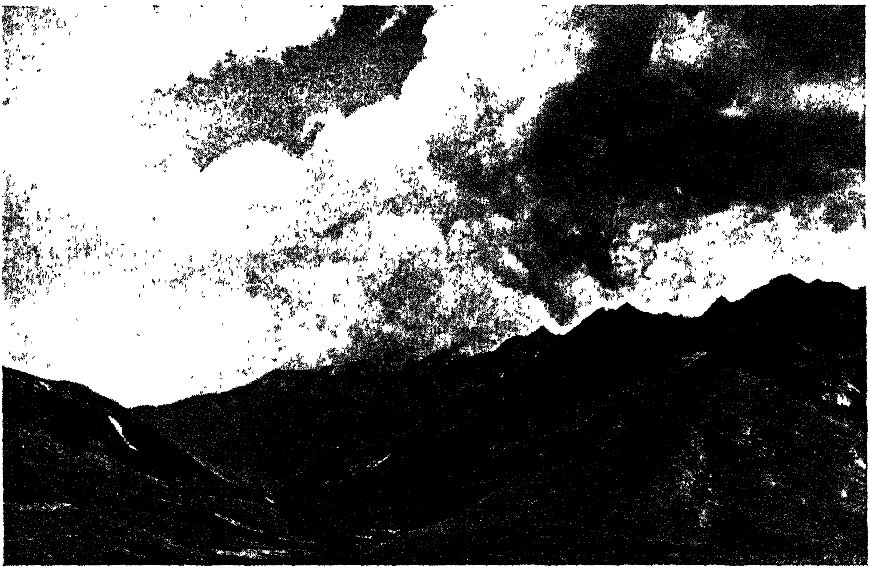

FIG. 4—View of the Cheto Shui from the Cheto La. "Armchair" corries may be seen on the left. The high peaks of the Ta Hsüeh Shan are obscured by clouds.

and the valley floor were covered with scree (Fig. 9). Immediately upstream, and well above the valley floor, Jurassic slates appeared on the southwest wall, dipping steeply to approximately north. A fault separated the slates from the gneiss, cutting transversely across the line of the Cheto Shui and the Cheto La; beyond, glacial forms were developed in the Jurassic series. Every step toward the head of the pass gave further evidence of past glaciation (Fig. 6) in hanging corries and scree-covered shoulders along the valley sides. No terminal moraine was seen in the Cheto Shui, but at 13,300 feet the valley floor contained a narrow whaleback of boulders, many of them large; it was about 100 yards long, with its axis parallel to that of the thalweg. Striae, rarely observed in the gneiss, were frequently found in the slates as well-marked grooves some quarter of an inch deep. At 13,600 feet the valley floor flattened noticeably and was occupied by a series of five whalebacks of boulders, roughly compacted by coarse grass and rising some 30 feet above the separating channels, which were themselves strewn with enormous

blocks of gneiss. No striae were found. A shoulder appeared on the northeast wall some 200 feet above the floor of the valley at this point. Looking back from the Cheto La, at 14,360 feet, we could see well-defined corries hanging high above the shoulder (Fig. 4), and to the north bare, rugged gneiss ridges rose from a rocky waste of boulders and rock fragments.

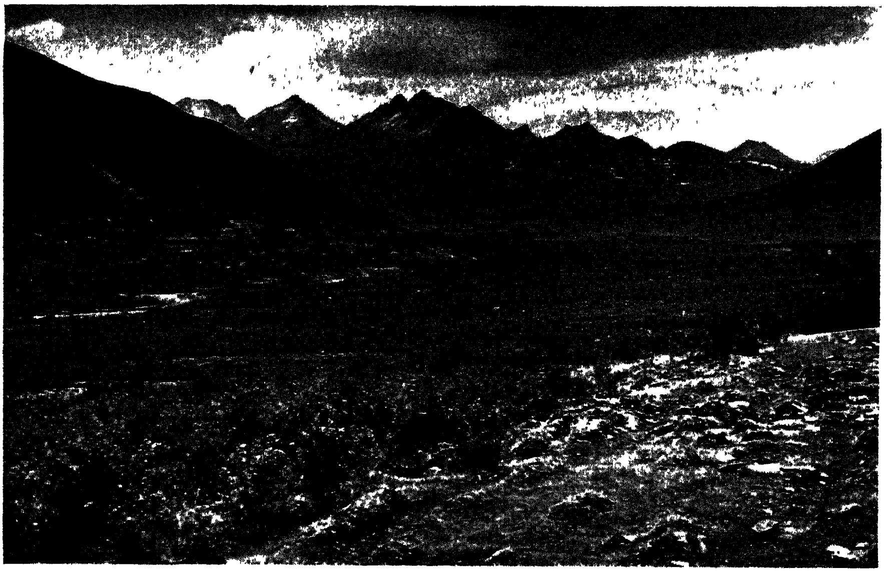

FIG. 5—View from a point near Tiju looking back toward the Cheto La. Unfortunately, the scree slope mentioned in the text can be only faintly discerned.

Numerous corries in process of disintegration were noted, many of them filled with scree. The snowfall here, and also in the topographically lower Jurassic area to the south of the pass, is so slight[3] that there can be no question of glacial activity in this area today.

From the neighborhood of the Cheto La (Fig. 5) a scree sloped westward, formed of slate flags and gneiss cobbles bound by turf with alpine plants; rents indicated that the mass was in movement. As Heim[4] had recognized, this was clearly a solifluction slope. West of the pass lay a series of some half a dozen well-developed, parallel, U-shaped valleys, with corries oriented north-northeast–south-southwest in the Jurassics at comparable

[3] Hanson-Lowe, Notes on the Climate of the South Chinese–Tibetan Borderland; A. Lu: The Precipitation of the Southeastern Tibetan Borderland, *Bull. Meteorol. Soc. of China*, Vol. 16, Nos. 1 and 2, 1942 (in Chinese). See also Mr. Lu's article, "Precipitation in the South Chinese–Tibetan Borderland," in this number of the *Geographical Review*.

[4] Arnold Heim: The Glaciation and Solifluction of Minya Gongkar, *Geogr. Journ.*, Vol. 87, 1936, pp. 444–454; reference on p. 449.

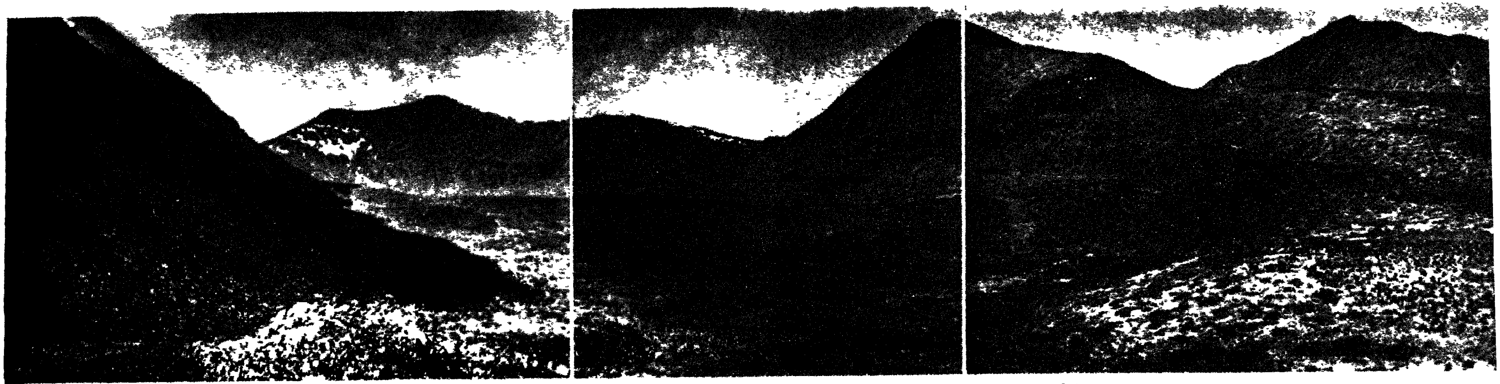

FIG. 6—The upper Cheto Shui. The Cheto La lies to the left beyond the limit of the picture.

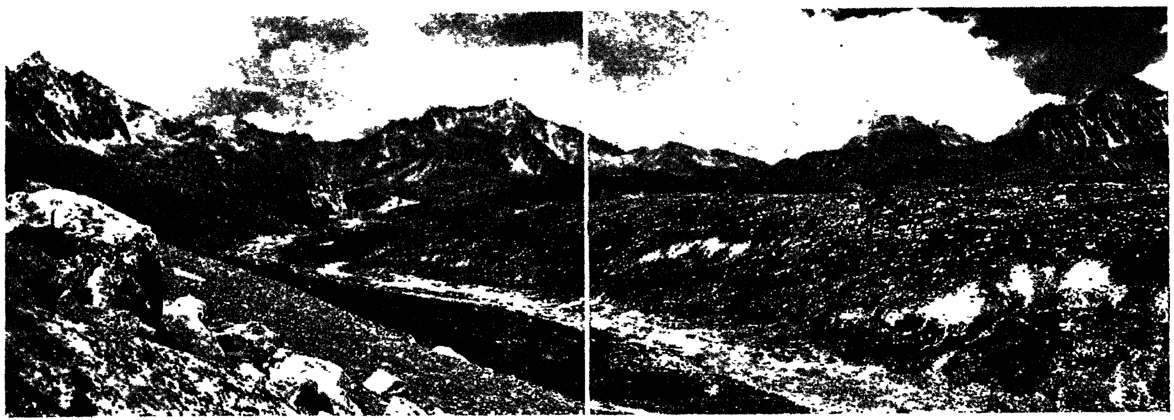

FIG. 7—Closer view of the corrie shown on the right in Figure 10.

elevations on the left wall of the valley near Tiju (Figs. 10 and 11). The corrie with the lowest lip was reached by way of a steep mass of scree that extended to the floor of the main valley and was covered with grass and scrubby bush. The elevation of the lip was 13,820 feet; that is, 1180 feet above the floor of the main valley. Its greatest width measured 700 feet (Fig. 7). The walls were fairly steep, with scree-covered slopes, and the gently sloping floor was strewn with grass-covered cobbles and fragments of slates and shales. The slope break at the lip was abrupt.

The main valley here lay at some 12,600 feet, with a very gentle longitudinal slope. The valley sides were markedly concave (Fig. 11); the right wall was spurless, the left one virtually so. Detritus from the scree slopes seemed to be clogging the valley more rapidly than the stream was capable of removing it—an impression strengthened and finally confirmed as the journey to Yingkwanchai proceeded. Shortly before reaching Nashi, we noted on the right wall a few hanging forms of a type similar to those mentioned in the last paragraph, oriented west-northwest–east-southeast. Just beyond Nashi others were seen, also on the right wall; they were the last such forms observed during this part of the journey.

Yingkwanchai to Lihwa

It is remarkable that nothing remotely resembling a corrie was seen between Nashi and the Rama La, not even on the Kaji La, at 14,890 feet. It is possible, however, that the rain and snow encountered and the consequent poor visibility obscured distant forms that otherwise would have been observed. Even on the Rama La, only hollows resembling nivation niches were seen, two at 14,620 feet and one at 14,560 feet, with talus heaps. Halfway between Hsiolo and Lihwa corrielike forms were seen on a ridge considerably higher than the point of observation, 14,380 feet, and somewhat farther west two uncertain ones were observed at heights of more than 14,600 feet.

To the south and southwest of Lihwa lay a considerably dissected mountain mass with numerous sharp peaks looking, when viewed from afar, like pyramids. Across the plain from Lihwa were three adjacent corries, of which the easternmost was the largest. Unfortunately, my own photographs, taken in the rain, are too poor for reproduction, but these same forms are clearly visible in a photograph appearing in a readily available publication by Heim,[5] though he does not single them out for attention. Indeed, it must be

[5] *Idem:* Minya Gongkar, Bern and Berlin, 1933, Pl. I, 3 (facing p. 224).

Fig. 8

Fig. 9

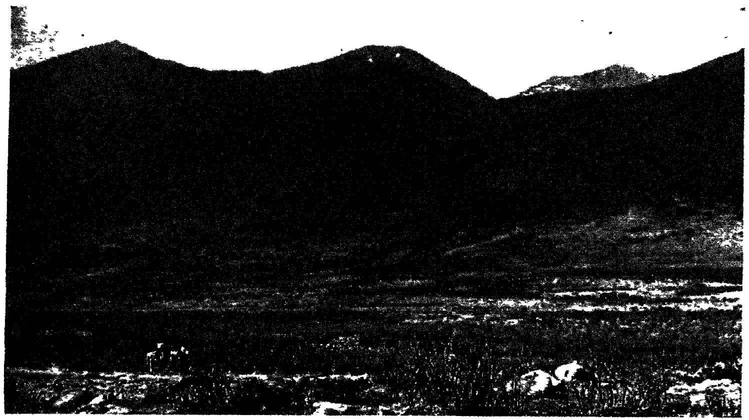

Fig. 10

Fig. 11

Fig. 8—Corries on the right wall of the Tarkio Valley.
Fig. 9—The Cheto Shui above 13,300 feet. The side slopes, concave upward, are covered with scree.
Fig. 10—Corries in the Tiju area.
Fig. 11—View upstream from below Tiju.

Fig. 12

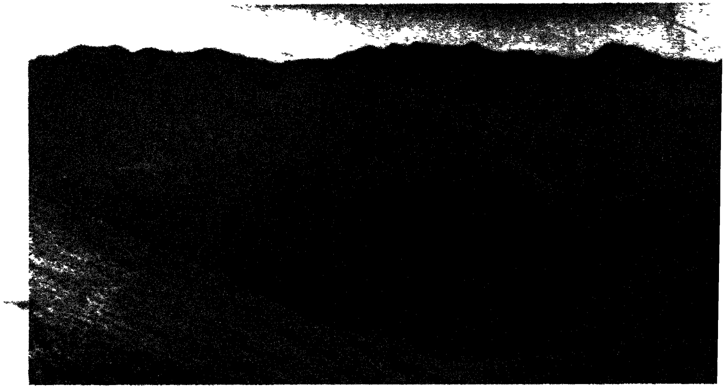

Fig. 13

Fig. 14

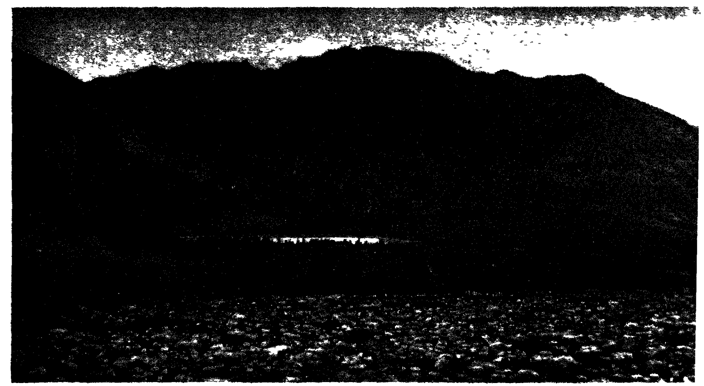

Fig. 15

Fig. 12—Hanging valley south of Lihwa. The Lama's Hat peak lies just out of view on the right.
Fig. 13—Deeply incised valley seen from the Ka Jen To Shan. The lower slopes are covered with spruce forest.
Fig. 14—Terminal moraine below Jara, view downstream.

admitted that regarded as glacial forms they are slightly equivocal, and in the short time at my disposal I could not carry out a thorough investigation. Nevertheless, I am sure that glaciation has played a part in their formation.

It was clear from the appearance of the mountains in which the corries were developed that the rocks forming the mass could not belong to the Jurassic sediments.[6] On investigation they were found to consist of a gray and whitish-gray granite, as Heim has noted,[7] and were frequently coarse in texture. The granite weathers readily, and in spite of a diligent search no striated blocks were seen during our ascent to the central and eastern corries, which are separated by the so-called "Lama's Hat" peak. The climb to the eastern corrie was made up a steeply inclined mass of boulders and cobbles (morainic material?) to the mouth of the corrie, at 14,890 feet, where the break in slope was strongly marked. It was disappointing that a heavy rain should begin just as we reached the corrie, making observation difficult and ruining the chances for good photography. The walls were of bare rock, rather steep and largely covered with scree. A few small patches of snow remained—these corries face north—and on the floor and lower slopes some scrubby rhododendron was growing (Fig. 12). Within the corrie itself were small hanging corries, and at least two arcuate masses of boulders and cobbles were observed above the lip. Between this corrie and the central one was a steep, boulder-covered slope. From it the details of the high-rounded, grassy Jurassic slopes on the north side of the Lihwa plain could be seen fairly well, as the rain abated on our return journey. Nothing resembling a glacial form was noted.

Lihwa to Kantse

From Lihwa the way led northward to Kantse. Some doubtful nivation hollows were seen about 12 miles north of Lihwa, but the most interesting features observed were some 40 miles north of that settlement, beyond the Ka Jen To Shan pass. From the pass, at 15,430 feet, we looked down into a deeply incised, V-shaped valley where the polycyclic nature of the landscape forms was clearly visible (Fig. 13). The wide upper parts of many of the left-bank tributary valleys showed a marked tendency to hang. These tributaries, short and closely spaced, and oriented toward the southwest, were developed in the Jurassic slates and shales. The right-bank tributaries also tended to hang, and in the flattened parts were large screes. Nearer the Sara La these tributaries, viewed from some 14,200 feet, were striking,

[6] It is unfortunate that Tan and Lee's atlas indicates Jurassics here.

[7] Heim, Minya Gongkar.

and since we had now advanced well upstream in the main valley, we were almost on a level with the flattened upper parts. Near the junctions with the main valley the tributaries, still developed in the easily weathered Jurassic series, were some 200 to 250 yards wide. They were U-shaped in cross profile and contained much scree. Their side walls were steep, and the ridges separating them had frequently been reduced to a knife edge. Below the pass the main stream was no longer deeply incised and the valley slopes were gentler and scree-covered, with a shoulder on the left wall, though nothing resembling a moraine was observed. Just below the shoulder the tributaries hung at their junctions with the main valley, at an elevation of about 15,000 feet. From the mouth of each a large talus cone descended to the main valley, in some cases tending to block the mouth. The floors of the tributary valleys were often hummocky with scree, and a few patches of snow were seen in June. Unfortunately, the weather was bad, reducing visibility and making photography almost impossible. As we crossed the Sara La, at 16,100 feet, there was a heavy fall of hail.

Caution must be exercised in attributing these landforms to glacial action There is no reason to suppose that a glacier ever occupied the main valley, though a small ice tongue may have held its uppermost part. Indeed, the polycyclic nature of the major landforms in this area of rocks not highly resistant to erosion suggests the possible presence of hanging forms where, for example, a phase of rejuvenation had resulted in the main stream's being incised more rapidly than its tributaries. Nevertheless, the appearance, particularly in the upper parts, of the hanging valleys seen from the Ka Jen To Shan, and even more strikingly from the Sara La, does strongly suggest that small corrie glaciers once occupied them, headwall sapping gradually giving rise to the elongated form of many of the corries. In any case, it is quite possible that névés occupied the upper parts of hanging tributaries that were already in existence as a result of some nonglacial cause such as rejuvenation. The fact that the Ka Jen To Shan and Sara passes are snowbound from late December through January and February suggests that snow accumulation in the hanging tributaries may be considerable even today and was probably much greater at the time when the Cheto corries were formed.

On the other side of the Sara La the Mofangkow Valley was entered. Just north of the pass small hanging valleys were noted at about 14,700 feet. The journey was continued to Chanhwa, Kantse, and Taofu, but no landforms observed on the way suggested glaciation. However, about 12 miles to the southeast of Kantse rose a cluster of summits known under the col-

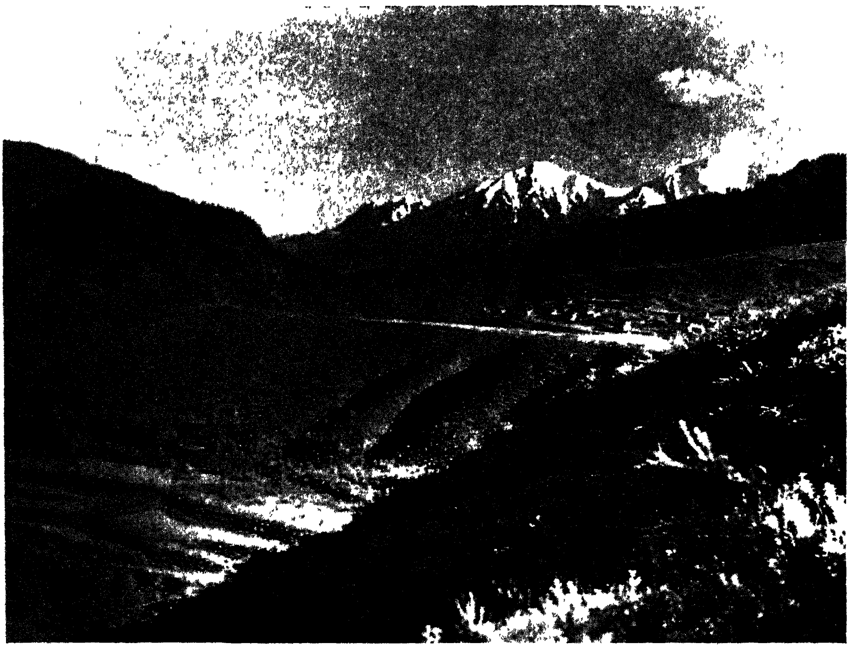

FIG. 16—The Ka Wa Lu Jih seen from the Yalung Valley, looking north. Note the rock-cut terrace with Tibetan houses beyond and man-modified alluvial terraces below. The river lies to the left of the picture.

lective name of Ka Wa Lu Jih (Fig. 16), and field glasses revealed what appeared to be a névé of considerable size occupying a depression between the two nearer peaks. The mountains could be seen particularly well from a point on the Yalung River about 10½ miles to the south, from Kantse, and from a spot some 8 miles to the north of the peaks. From these three stations prismatic-compass bearings were taken to the peaks, and the angles of elevation measured by means of an Abney level. Although the method gives only a rough approximation, the values obtained from the three stations agree so closely that it seems worth while to give the maximum elevation, which was found to be slightly more than 18,000 feet. The snow line on the northwest side (June) was found to lie at about 17,000 feet.

Kantse to Kangting

Some 14 miles to the northwest of Taofu two small hanging valleys were noted on a crest west of the Lu Ho (She Chu). They appeared to lie several thousand feet above the point of observation on the east bank (10,400 feet). No signs of glaciation were observed in the Taofu area, though we kept to the valley. Arnold Heim, who visited this area in 1930, approaching

it from the highland on the west, declares that the erosional features are due entirely to water.[8] From the Sunglinkow Pass, 13,280 feet, forms suggestive of glaciation were seen on bare summits to the west, an estimated 1500 feet or more above the pass.

Beyond Taining we approached the mountain barrier between China and the plateau of southeastern Tibet along a deeply cut, steep-walled valley. Its floor was strewn with great boulders and masses of tumbled rock, mainly of granite-gneiss, and the junctions of many of the tributaries with the main stream were almost blocked by great piles of debris, usually covered with vegetation. Above 12,260 feet (stream level) the valley widened and flattened somewhat, and several corries were seen about a thousand feet above its floor. At 12,450 feet an arcuate terminal moraine, rising some 40 feet above the stream that cut through it, stretched across the valley (Figs. 14 and 17); associated with it were much smaller arcuate piles of morainic material. The upstream eastern side presented a smoothed appearance, clearly visible in the photographs, due perhaps to local overriding of the ice, or even to the deposition of sand and gravels between the valley wall, the moraine, and the stagnant ice in the valley. Although our journey up this valley was rapid, the field evidence suggested that the glacial tongue may once have extended a mile or two beyond the terminal moraine.

Above the moraine the valley floor was well covered with grass, bushes, and stands of spruce. There was much scree on the lower slopes. As we approached Jara, the valley swung to S 16° 30′ W (Fig. 18). Our route, however, led eastward up an enormous morainic mound behind which lay a small bluish-green lake fed by a waterfall from the melting ice of Jara (Fig. 15). Beyond the mound rose an upland of scree and soliflucted material, much of it doubtless of morainic origin, and over all towered the imposing mass of Jara, nearly 20,000 feet high. On the upland, the Haitze Shan, lay two other lakes, with overflow channels.

Beyond the Haitze Shan a steep descent led past great morainic heaps into a rectilinear valley where the Jurassics of the east wall were faulted against the gneiss of the west. What appeared to be a terminal moraine was observed immediately above Hsintientze, at 11,260 feet. Below that point there was no clear evidence of moraine; the valley was still rather flat and was bordered by high debris fans. A short distance above Chungku, at 10,600 feet, the valley turned and became definitely gorgelike. This upper part of the valley

[8] Earthquake Region of Taofu, *Bull. Geol. Soc. of America*, Vol. 145, 1934, pp. 1035–1049; reference on p. 1037.

FIG. 17

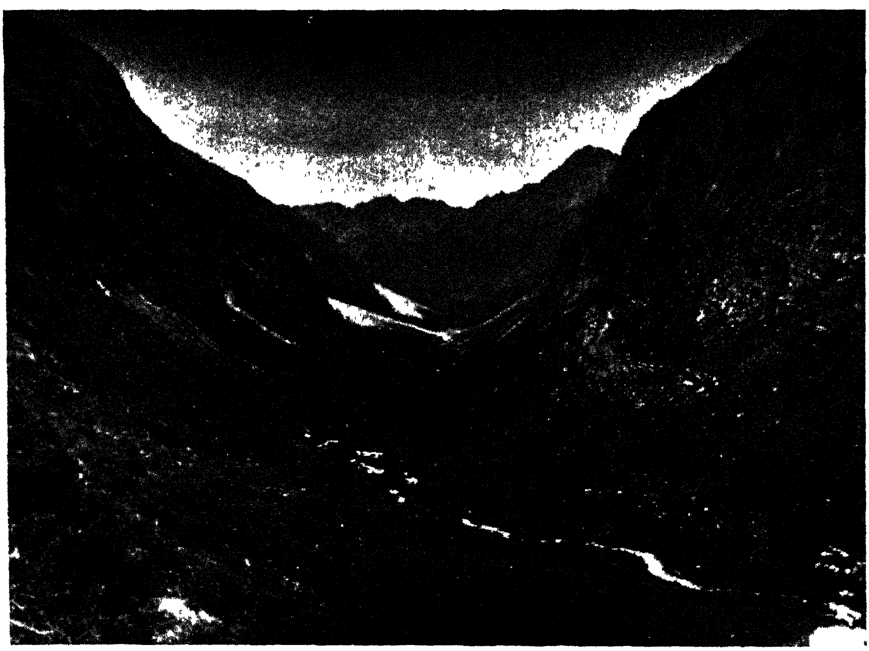

FIG. 18

FIG. 17—The peak of Jara. Terminal moraine in the foreground.
FIG. 18—View upstream near Jara.

is shown in an admirable panoramic photograph by Tafel[9] and is described by Von Wissmann as exemplifying a trough valley of classical form.[10] Although glaciation has unquestionably had much to do with fashioning the upper part of the valley, near Jara, I hesitate to accept the large-scale glaciation that Von Wissmann's remark would seem to imply. Below Chungku no glacial forms were observed.

Correlation of Levels

An attempt has been made to show exactly where glacially produced landforms were seen and to indicate their altitudes. Table I summarizes these locations and elevations, though it must be remembered that in a few cases there was some doubt as to the authenticity of glacial origin.

Table I—Locations and Elevations (Approximate) of Glacially Produced Landforms

(Elevations in feet)

LOCALITY	ELEVATION	LOCALITY	ELEVATION
Corries		*Corries*	
S of Kangting	13,000	(NW of Taofu)	(Several thousand feet above 10,400)
S of Cheto hamlet	13,300	Sunglinkow Pass	14,800 (estimated from observation level of 13,280)
In the Tarkio Valley	13,360 (and above)	Valley NW of Jara	13,260
E of Cheto La	13,800	*Glaciated Valleys*	
At Cheto La	14,360 (and above)	In the Cheto Shui	Down to 13,600
Near Tiju	13,820	Valley NW of Jara	Down to 12,450 (perhaps to 12,260)
Rama La nivation niches	14,600	Valley SE of Jara	Down to 11,260 (perhaps even lower)
Halfway between Hsiolo and Lihwa	14,380 and 14,600		
Opposite (i.e. S of) Lihwa	14,890		
Between Ka Jen To Shan and Sara La	15,000		
Mofangkow Valley	14,700		

Conclusions

From the preceding discussion it is clear that glacial action took place in the region at altitudes considerably lower than is at present the case—a

[9] Albert Tafel: Meine Tibetreise, 2 vols., Stuttgart, Berlin, Leipzig, 1914, Vol. 1, Pl. 44 (facing p. 193).

[10] Hermann von Wissmann: Die quartäre Vergletscherung in China, *Zeitschr. Gesell. für Erdkunde zu Berlin*, 1937, pp. 241–262; reference on p. 244.

conclusion that supports the findings of Von Lóczy, Tafel, and Heim[11]—probably during the Pleistocene. The available data do not prove that the glacial features were fashioned contemporaneously or approximately so. However, given the similarity in degree of preservation and size of the corries, together with the fairly regular westward increase in the elevations of the lowest observed corries, it is perhaps not unreasonable to suggest that the glacial forms do belong to the same period. It is clear, furthermore, that the lowering of the snow line did not cause a spectacular glaciation at levels below the glaciated areas of today. Increased alimentation permitted existing glaciers to descend to lower elevations than they do now. Probably there were also some additional valley glaciers, some of them small, as seems likely at the Cheto La and perhaps near the Sara La, others larger, as appears probable northwest of Jara.[12] At the same time, on the higher crests near the bordering mountains on the east and also in favored positions on the more elevated parts of the adjacent plateau, corries and nivation cirques were formed. I see no necessity for the presence of ice sheets covering extensive areas of the plateau, at least in the region I have traversed. It is worth quoting Heim here, with regard to glaciation in the Minya Konka area: "The former glaciers were more widely extended than they are now, but not to compare with the pleistocene glaciation of the Alps. The former glacier tongues reached 200 to 500 metres farther down at the most."[13] Heim estimates that in this region the ratio between the present glacier lengths (taken as 1) and the former lengths ranges from 1:1.1 to 1:1.6, whereas in the Alps the ratio is 1:12 to 1:30. It will be remembered that my observations indicated glacial action down to 12,450 feet northwest of Jara (perhaps even to 12,300 feet) and to 11,260 feet at Hsintientze, southeast of Jara (and doubtfully down to 10,600 feet or thereabouts).

Table I makes clear the increase in the elevations of the lowest observed corries from east to west; that is, with decreasing precipitation, with advance into the plateau, and with increasing distance from the Ta Hsüeh Shan and its present centers of glaciation. Thus some 2½ or 3 miles from the Tatsienlu

[11] Ludwig von Lóczy: Beschreibung der geologischen Beobachtungen und deren Resultate, *in* Die wissenschaftlichen Ergebnisse der Reise des Grafen Béla Széchenyi in Ostasien, 1877–1880 (3 vols. and atlas, Vienna, 1893–1899), Vol. 1, pp. 307–837; Tafel, *op. cit.;* and Heim, The Glaciation and Solifluction of Minya Gongkar. For a discussion of new evidence of low-level glaciation in adjacent Szechwan see W. B. Harland: On the Physiographical History of Western Szechwan with Special Reference to the Ice Age in the Red Basin, *Journ. West China Border Research Soc.,* Vol. 15, Ser. B, 1945, pp. 1–19, and a review of Harland's paper by H. B. Whittington: The Physiographical History of Western Szechuan—A Review and Discussion, *Geol. Mag.,* Vol. 83, 1946, pp. 141–146.

[12] It should be noted that in this last case the glaciated valley was not followed to its source. It is unlikely, however, that there is at present any valley-head glacier there.

[13] Heim, The Glaciation and Solifluction of Minya Gongkar, p. 450.

Glacier the elevation is about 13,000 feet; in the Cheto area, from 13,300 to 13,360 feet; at Tiju, 13,820 feet. In the longitude of Lihwa (including Lihwa, the area between the Ka Jen To Shan and the Sara La, and the Mofangkow centers) it is from 14,700 to 15,000 feet. There is therefore an increase in elevation of some 2000 feet over a distance of about 100 miles in an east-west direction, or about 20 feet to a mile, though the initial slope as far as Tiju is roughly twice as steep.

Assuming the approximate contemporaneousness of formation of the corries, it is important to compare the altitude of the snow line at the time of corrie formation with its present position. Heim states that "the snow line, on account of bad weather, could not be determined accurately. On the west side of Minya Gongkar it seems to be between 5200 and 5400 metres" [17,060 and 17,716 feet].[14] Burdsall, who in 1932 made the first ascent of Minya Konka, indicates on his map that the snow line lies at about 17,000 feet.[15] Weigold, who made two journeys in southeastern Tibet, states that the limit of everlasting snow lies at some 5300 to 5400 meters [17,388 to 17,716 feet] in the east and becomes increasingly higher as one penetrates into the Tibetan interior.[16] Kingdon Ward has given it as his opinion that the snow line of the mountains about Kangting "may be taken as 17,000 feet, possibly 17,500."[17] The average of these figures is about 17,300 feet. A comparison of this with the altitudes of the corries of the Kangting area indicates that the snow line at the time of corrie formation was lower by some 4000 feet than it is at present in the eastern part of the region. It is of interest here to note Von Wissmann's statement: "The difference in elevation between the snow line of today and that of the late Ice Age consequently amounts to about 1200 m. in the Yülung Shan, in northern Yünnan [about 200 miles south-southwest of the Kangting area], a figure corresponding to the average value for the Alps. This is the only place in China where we have so far been able to establish precisely the depression of the late Ice Age snow line below that of today."[18] Since 1200 meters is only 63 feet short of 4000 feet, the correlation is striking. Unfortunately, the data are insufficient for the determination of the position of the present-day snow line westward from the Ta Hsüeh Shan, so that it is not possible to calculate the depression of the snow line for corries farther to the west.

[14] *Ibid.*, p. 447.

[15] R. L. Burdsall: The Altitude and Location of Minya Konka, *Geogr. Rev.*, Vol. 24, 1934, pp. 118-128, Fig. 1 (p. 119).

[16] Hugo Weigold: Südost-Tibet als Lebensraum, *Jahrbuch Geogr. Gesell. zu Hannover für 1934 und 1935*, 1935, pp. 203-247; reference on p. 236.

[17] Quoted in "The Mountains about Tatsienlu," *Geogr. Journ.*, Vol. 75, 1930, pp. 345-352; reference on p. 345.

[18] *Op. cit.*, p. 242.

PRECIPITATION IN THE SOUTH CHINESE-TIBETAN BORDERLAND*

A. LU

THE term "South Chinese-Tibetan borderland" as used here refers to the region between approximately 95° and 105° E. and 28° and 33° N. (Fig. 1). It embraces the valleys of the Min, Yalung, and Kinsha Rivers and the headwaters of the Lantsang. Lying between the Red (Szechwan) Basin, which has an average elevation of 500 meters, and the lofty Tibetan plateau, more than 5000 meters above sea level, it is a region of complex and rugged relief. High mountains tower above deep gorges trending generally north-south. In general, the elevation is more than 1500 meters. In such rugged country there is of course a considerable diversity of climate and scenery; dry steppes in the valley bottoms form a striking contrast with the luxuriant primeval forests of the mountain slopes.

Despite the distance from the Pacific, the region lies within the reign of the southeast monsoon that surges in from the South China Sea in summer.[1] Pilot-balloon soundings have revealed that the summer monsoon in West China usually reaches a height of more than 5000 meters and hence easily spreads over eastern Tibet without obstruction. The lofty border ranges of the plateau, however, force the monsoon to deposit its moisture on their windward slopes and act as a continuous rain screen. Precipitation decreases abruptly westward. On the eastern slopes of the ranges the normal annual precipitation is about 2000 millimeters; to the west the annual means are rarely more than 600 millimeters. In Sikang the yearly averages range from about 700 millimeters in the southeast to less than 500 millimeters in the northwest, undoubtedly a natural result of the direction of the prevailing moisture-bearing winds and the northwestward increase in elevation.

Because of the mountain barrier in the southeast, the upper Min Valley

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* Because of difficulties of communication the author has been unable to read proof.—EDIT. NOTE.

[1] The following references were used in the preparation of this article:

Coching Chu: The Enigma of the Southeast Monsoon in China, *Journ. Geogr. Soc. of China*, Vol. 1, No. 1, 1934.

P. H. Chu: Meteorological Reports on S. Sikang Expedition, *Journ. Geogr. Soc. of China*, Vol. 7.

J. H. Edgar: Notes on Temperatures in High Altitudes on the Tibetan Border, *Journ. North-China Branch Royal Asiatic Soc.*, Vol. 45, 1914, pp. 57–64.

J. Hanson-Lowe: Notes on the Climate of the South Chinese-Tibetan Borderland, *Geogr. Rev.*, Vol. 31, 1941, pp. 444–453.

A. Lu: Frontology of China, *Meteorol. Mag.*, Vol. 16.

C.-W. Tu: The Precipitation of the Omei, *Meteorol. Mag.*, Vol. 12, No. 7.

G. C. Yang: The Upper Air Currents over Southern Szechwan, *Meteorol. Mag.*, Vol. 15, No. 3–4.

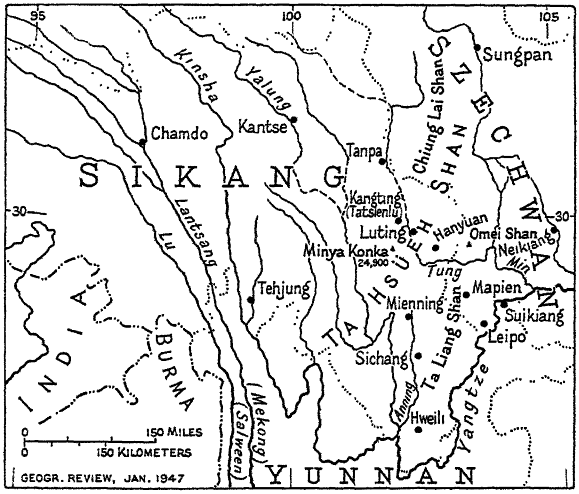

FIG. 1

receives the least rain: the yearly average is less than 400 millimeters (Fig. 2). The aridity of the climate is clearly reflected in the alkali soils, the halophytic plants, and the flat earth roofs of the dwellings—scenery generally resembling that of the dry steppes and deserts north of the Great Wall. West of the upper Min precipitation increases slightly with altitude, but even on the high slopes of the Chiung Lai Shan short grass is dominant up to the 5000-meter level. Above that, boreal coniferous forests begin. Judging from the vegetation and from the annual precipitation of Sungpan (650 mm.), the rainfall on the eastern slopes of the Chiung Lai Shan may be safely estimated as about 1000 millimeters at the 3000-meter level, 500 to 1000 millimeters between 2000 and 3000 meters, and less than 500 millimeters below 2000 meters.

The eastern slopes of the Chia King Shan and the Ta Hsiang Ling, directly facing the moist summer monsoon, are noted for their abundant rainfall. An old saying has it that "in western Szechwan the sky is leaky." During the second polar year (August, 1932, to August, 1933) the total precipitation recorded at the summit of Omei Shan was 9236 millimeters, the largest amount ever recorded in China in a 13-month period. But the variability of the precipitation is even more surprising. The annual mean taken from observations of recent years is slightly less than 2000 millimeters. The orographical effect on the distribution of the precipitation in the Omei Shan region is indicated by the following records:

STATION	DISTANCE (*km.*)	HEIGHT (*m.*)	ANNUAL MEAN (*mm.*)
Omei Shan	0	3097	1860
Omei	15	800	1510
Loshan	33	320	1220
Neikiang	160	352	1060

Beyond the ridges of the Chiung Lai Shan and the Chia King Shan rainfall decreases abruptly. Tanpa, in the Tung (Ta-tu) Valley at 3000 meters, receives only about 450 millimeters a year. An arid climate prevails also in

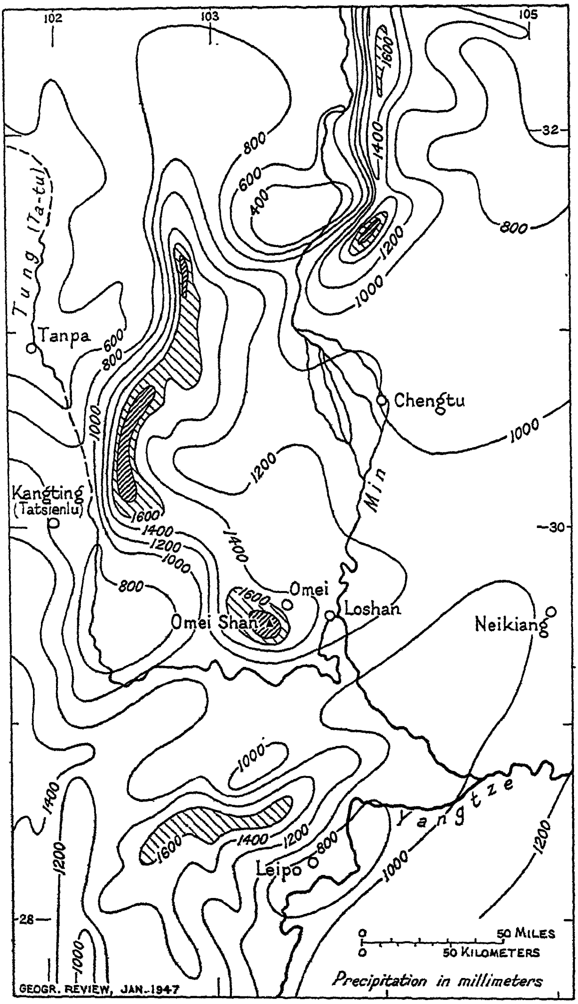

FIG. 2—Precipitation map of the eastern section of the area shown in Fig. 1.

the vicinity of Luting, where cactus appears. Below Luting the valley widens and south of Hanyuan bends eastward, thus opening out to the invasion of the moist monsoon winds. Precipitation increases downstream until at the confluence of the Tung and the Min it reaches 1000 millimeters and more. The gorges of the Mapien and the Yachun Rivers have a trend almost at right angles to the prevailing moist winds and naturally receive less rainfall. The annual average at Mapien is no more than 900 millimeters. The low-lying valley of the Kinsha between Suikiang and Leipo, sheltered by the Ta Liang Shan and the Kweichow escarpment, is one of the driest districts in western Szechwan, second only to the upper Min Valley. Here the precipitation normally approaches 700 millimeters but increases slightly to the north. At Suikiang the annual total reaches some 1000 millimeters.

Records are not available for the northern part of the Ta Hsüeh Shan. The precipitation is probably less than 1000 millimeters, even on the eastern slopes. Kangting (Tatsienlu), at 2600 meters, receives an average of 810 millimeters a year. The southeastern slopes, however, receive a little more: Hweili, Sichang, and Mienning, in the valley of the Anning, all record an annual total of more than 1000 millimeters. But on the leeward side and in some enclosed basins the rainfall is generally less than 600 millimeters a year.

West of the Ta Hsüeh Shan precipitation decreases again. On the high slopes the mean values range from 700 to 800 millimeters; in the sheltered valleys they usually drop below 500 millimeters. The rainfall of Sikang decreases not only from east to west but also from south to north. The only exception is the enclosed Tehjung Basin, which receives 310 millimeters in a normal year—even less than the annual total for Chamdo in the northwest, where an average of 490 millimeters is recorded.

The Rainfall Regime

The rainy season of the borderland normally lasts from May to September. The winter is dry except for small amounts of precipitation in the form of snow. Only on the high passes does snow accumulate to more than a few centimeters, partly because of the scantiness of the fall and partly because in the windy air evaporation is rapid. The snows are usually accompanied by strong gales and sandstorms, during which the temperature often drops some 6° or 7° C. within a few hours.

About 75 to 95 per cent of the total annual precipitation falls in the five warm months. Strangely, most of the rain is concentrated in the late spring and early autumn rather than in midsummer, when the monsoon reaches its height: July shows a marked drop in the rainfall curves for most stations. Only a few stations in enclosed basins or on the summits of high mountains have recorded a midsummer maximum. In the western Red Basin the two maxima, in both amount of rainfall and monthly distribution of rainy days, usually occur in May and August, on the plateau in June and September.

It is obvious that topographical control is an important factor in the rainfall distribution of the region. But it is not correct to say that the precipitation is mainly orographic. The climax of orographic rainfall both in amount and in frequency should occur in midsummer, when the monsoon is strongest. But only on the summits of the high mountains have single July maxima been recorded. The daytime convectional thunderstorms of the hot season also bring some rain to the region and at a few stations in enclosed basins and valleys they account for a hump on the annual rainfall curve. They do not, however, explain the characteristic double maxima of the late spring and early autumn; in fact, it is clear that neither orography nor convection is the primary control responsible for the rainfall regime.

Frontal Activity

In winter the polar front of the Far East lies over the western part of the North Pacific and exerts no direct influence on the continent. The weather of China is then characterized mainly by intermittent outbursts of

Ps (polar Siberian) air. As spring comes, the polar front gradually moves northwestward toward and across the mainland. In May and June it is quasi-stationary to the south of the Yangtze, trending from east-northeast to west-southwest. Cyclones develop continuously and move one after another along the front toward the east or northeast; they account for the so-called "plum rains" throughout the Yangtze Valley. During these months the weather is gloomy and wet. The heavy late-spring rains of the borderland undoubtedly are caused by the same agency.

With the advent of summer, Tp (tropical Pacific) and Ep (equatorial Pacific) air masses become stronger and push the polar front northward to the Mongolian border. The Yangtze Valley is then left under the sole control of air masses coming from the southeastern seas. The "plum rains" cease, and thunderstorms of thermal origin are frequent. Convectional and orographic rains prevail in western Szechwan and eastern Sikang, but the amount is far less than that released through the polar-front activity of the late spring, and the rainfall curves drop accordingly.

In autumn the polar continental air mass recovers its power and carries the polar front back to its winter position. Since the level lowlands of eastern China offer no obstruction to its southward journey, the dominant polar air mass there brings cool and sunny weather, the most enjoyable of the year. In western China, however, the rugged relief causes the polar front to advance slowly and sometimes even to stagnate for days or weeks. Rainy weather therefore prevails again in the early autumn in the borderland.

An analysis of the weather of the Omei Shan made by Mr. C.-W. Tu is informative. The normal sequence of weather changes there may be summarized as follows:

1. During a short spell of fine weather gentle southerly winds prevail, with high temperature and humidity. Atmospheric pressure is high.

2. The sky becomes cloudy, intermittent drizzle sets in, and the atmospheric pressure drops gradually. (Typical warm-front weather.)

3. There is a burst of northerly or northwesterly cold air, followed by heavy rain. The pressure rises. (Typical cold-front weather.)

4. Fine weather returns, with high pressure, low temperature and humidity, and variable winds.

Similar conditions were observed by P. H. Chu during his expedition in southern Sikang. He arrived at the conclusion that the weather is generally fine when the moist southeasterly wind prevails and that cloudy and rainy weather accompanies the cold northers. Frontal cloud systems frequently appear as forerunners of the heavy rains.

These characteristics indicate that the precipitation of the South Chinese–Tibetan borderland is mainly frontal in origin and that convection and orography are controls of only secondary importance. It should be emphasized, however, that in rugged country such as this the effect of the topography on the distribution of the precipitation is appreciable, even when another agency is mainly responsible for the actual release of moisture from the atmosphere. The frontal activity is itself governed to some extent by the character of the relief.

EARLY SPANISH TOWN PLANNING IN THE NEW WORLD*

DAN STANISLAWSKI

FOR centuries before the discovery of the New World war was the major occupation of the Spaniards. The struggle to wrest Spain from the Moors developed a large number of vigorous and fearless men, efficient in the taking and exploring of new lands, but with little concept of, or aptitude for, the gentler and more difficult arts of peaceful organization.[1]

Because of her martial preoccupation, Spain took little, if any, part in the revitalized urbanization movement of Western Europe. In virtually all her neighbors, an awareness of the need for town planning had been steadily growing for generations. Serious thought had been given to the problem, and steps had been taken to meet it. The French, for example, had had considerable and successful experience in the establishment of the bastides and *villes-neuves*. The English, patterning after the French, had set up numerous planned towns. The Italians were far from being tyros in the field. Even the people of Central Europe had had some experience in town planning.

But it was not so with Spain. The idea that a town should be established according to a preconceived pattern was foreign to a Spaniard. Although there were numerous Roman foundations in Iberia, many of considerable size and importance, they had been transformed in the long interim from meticulously plotted grids into formless cities with tortuous streets and alleys.[2]

It was singularly unfortunate, both for the Spaniards and for the Indians of the New World, that Spain was uninformed in town planning. Towns were needed for control, for distribution of goods, for taxes, labor, and conversion to Christianity. Yet the conquistadors burst into the New World

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*This article is a sequel to Dan Stanislawski: The Origin and Spread of the Grid-Pattern Town, *Geogr. Rev.*, Vol. 36, 1946, pp. 105–120.

[1] L. B. Simpson: The Encomienda in New Spain, *Univ. of California Publs. in History*, Vol. 19, 1929, p. 78.

[2] This was the result of two factors. First, the centralized power and urban emphasis of the Romans broke down and was succeeded by Visigothic decentralization and feudal control. Second, the Visigoths were conquered by the Saracens, and Iberia everywhere was affected by Moorish ideas. The typical Moorish city has always been erratic.

Only a few remnants of the precise Roman plans were left as examples for the rulers of expanding Iberia; for example, hardly recognizable traces in Braga, in what is now Portugal (see F. Haverfield: Ancient Town-Planning, Oxford, 1913, pp. 103–104), and in Tarragona and Mérida in Spain (see Ramón Menéndez Pidal: Historia de España, Vol. 2, España Romana, Madrid, 1935, p. 607). But so little was left that it is doubtful whether there were serviceable models for the sixteenth century.

with hardly another idea than simple conquest and quick riches. They destroyed many native communities, some strongly knit by an old and satisfactory social organization, yet they had nothing to substitute. The history of Spanish control of the New World before the conquest of Mexico is largely a record of administrative chaos. This is clearly reflected in the crudity of early attempts to establish the necessary urban units.

First Instructions from the Spanish King

The early settlements on the Caribbean islands were founded without more precautions as to site, resources, and pattern than could be expected from unschooled, hard-bitten soldiers whose knowledge of urbanization was undoubtedly circumscribed by their barracks walls. The early instructions from Ferdinand to his governors and captains in the New World indicate that he left the matter to their judgment. Take, for example, his instructions to Ovando in 1501:

> As it is necessary in the island of Española to make settlements and from here it is not possible to give precise instructions, investigate the possible sites, and in conformity with the quality of the land and sites as well as with the present population outside present settlements establish settlements in the numbers and in the places that seem proper to you.[3]

Similarly, his instructions of 1509 to Diego Colon were to "establish settlements where it seems best to you." However, in the same year the monarch ordered Diego Colon to observe differences in the quality and merit of persons to be given lands. Up to that time such differences had not been observed, says the order.[4] This was more than merely bolstering the prestige of the "better people." It was a recognition of the importance of the possession of land and one of the first fumbling gestures toward the necessary centralized planning of land distribution.

The conquistadors' casual manner of setting up new towns according to their "best judgment" was far from satisfactory either to the Indians or to the Spaniards themselves. After nearly a generation of exploitation the gold of the Antilles was fairly well worked out. Treasures of all kinds had rewarded a comparatively few men, and the less glittering but sounder values of land were becoming evident even to Spanish adventurers.

When land becomes important, the method of measuring and apportioning it is of corollary importance, for both rural and town properties. Here

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[3] Colección de documentos inéditos relativos al descubrimiento, conquista y colonización de las posesiones españolas en América y Oceanía, sacados, en su mayor parte, del Real Archivo de Indias (42 vols., Madrid, 1864–1884; referred to hereinafter as D I I), Vol. 31, 1879, pp. 17–18.

[4] *Ibid.*, pp. 393 and 501.

Spain needed assistance. This was a new field for her officials, and quite naturally they turned to the plans that they knew. For even if the Roman cities of Spain had lost their original form, the record of that form and the record of Roman distribution of land were still available. More, there were the records of still earlier Greek planners to use, where these differed from the Roman and were better suited to the Spanish requirements.

Greek and Roman Basis of Early Plans

It was only after a generation in the New World that precise instructions, based on Roman and Greek experience, were given to the officials regarding the establishment of towns, their form, and the distribution of lots. The following instructions were given by the king to Pedrarias Dávila in 1513:

> One of the most important things to observe is that . . . the places chosen for settlement . . . be healthy and not swampy, good for unloading goods [if ports]; if inland to be on a river if possible, . . . good water and air, close to arable land. . . .
>
> In view of these things necessary for settlements, and seeking the best site in these terms for the town, then divide the plots for houses, these to be according to the status of the persons, and from the beginning it should be according to a definite arrangement; for the manner of setting up the *solares* will determine the pattern of the town, both in the position of the plaza and the church and in the pattern of streets, for towns being newly founded may be established according to plan without difficulty. If not started with form, they will never attain it.[5]

The instructions to Pedrarias Dávila imply the use of the grid plan, with straight streets either parallel or at right angles to one another. The phraseology clearly indicates a basis in Roman planning, which in turn was founded on the use of the grid. The lack of a definite and detailed description of the grid may be the reason for its failure to appear in the New World for years after these instructions were given. Or in these feverish years in the badly declining Antilles and in the dangerous, discouraging north coast of South America there may have been little opportunity for putting such instructions into practice. Or Spanish captains may have exercised their immemorially cherished prerogative of *obedezco pero no cumplo*.

It is interesting and important to note that accompanying Pedrarias Dávila was one Alonso García Bravo,[6] who was later described by Cortes as "a good geometer" and who was employed by him in the planning of the grid of Mexico City.

Although the following decade saw no fulfillment of these instructions to Pedrarias Dávila, they were not forgotten. Indeed, they were repeated

[5] D I I, Vol. 39, 1883, pp. 284–285.

[6] Manuel Toussaint, Federico Gómez de Orozco, and Justino Fernández: Planos de la ciudad de México, Mexico, 1938, pp. 36 and 109.

on several occasions to other Spaniards who might be involved in setting up new communities. In 1518 the king repeated the salient items in his instructions to the Jeronymites.[7] Francisco de Garay was sent instructions for the settlement of the "province of Amichel," dated 1521, which covered the same points and contained many of the same phrases.[8] This document was duplicated in that year, to be sent as general instructions from the king to all those making discoveries in the mainland and was duplicated again for Cortes.[9]

Plan of Mexico City

That Cortes had received instructions before those specifically addressed to him is evident; for by the time a document dated in Valladolid on June 26, 1523, would have reached him, Mexico City was well on the way to completion, planned in accordance with the royal wishes. The point of immediate interest is that, in spite of the many instructions of this type sent by the king to his captains overseas, Cortes was probably the first to put them into effect.

It has been suggested that the form of Tenochtitlán, the native city on the site of the present Mexico City, was that of a grid, that probably the grid was not unknown before the Conquest.[10] There is no convincing evidence of any grid-pattern town in the New World before Cortes rebuilt Mexico City.[11] Cortes clearly implies that two or three streets of Tenochtitlán were straight and that the rest were not.[12] Bernal Díaz del Castillo and the Anonymous Conqueror, by their failure to mention what would certainly have been a striking sight to a Spaniard who had never known of such a pattern, also strongly indicate the absence of the grid.[13] Cervantes de Salazar,

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[7] D I I, Vol. 23, 1875, p. 314.

[8] Martín Fernández de Navarrete: Colección de los viages y descubrimientos . . . , 5 vols., Madrid, 1825–1837; reference in Vol. 3, pp. 149–150.

[9] Colección de documentos inéditos relativos al descubrimiento, conquista y organización de las antiguas posesiones españolas de ultramar, Ser. 2 (17 vols., Madrid, 1885–1925), Vol. 9, 1895, p. 167.

[10] George Kubler: Mexican Urbanism in the Sixteenth Century, *Art Bull.*, Vol. 24, 1942, pp. 160–171.

[11] There is some question about the city of Veracruz. It has been suggested that it was set up as a grid, and there is some inferential evidence that points to such a conclusion. Also, there is the fact that Alonso Gracía Bravo was there and may have been employed in its establishment (see Toussaint *et al.*, *op. cit.*, p. 21). On the negative side, however, is the fact that the Spaniards at that moment were not interested in the distribution of plots of land. They were on their way to conquest, fame, and fortune.

[12] Hernando Cortes: Cartas de relación, Madrid, 1932, Vol. 1, p. 98 (carta segunda).

[13] Bernal Díaz del Castillo: Historia verdadera de la conquista de la Nueva España, 3 vols., Mexico, 1939, reference in Vol. 1, pp. 309 ff; "Narrative of Some Things of New Spain and of the Great City of Temestitan, Mexico," written by the Anonymous Conqueror, translated into English and annotated by M. H. Saville (Documents and Narratives concerning the Discovery and Conquest of Latin America, No. 1), The Cortes Society, New York, 1917.

whose works were critically read in the middle of the sixteenth century by conquistadors then living in Mexico City, has left us a description of the city in the form of dialogues. Two of his characters, walking through the fine straight streets, finally reach the native quarter, where they go no farther, for, it is stated, from there outward are the humble huts of the

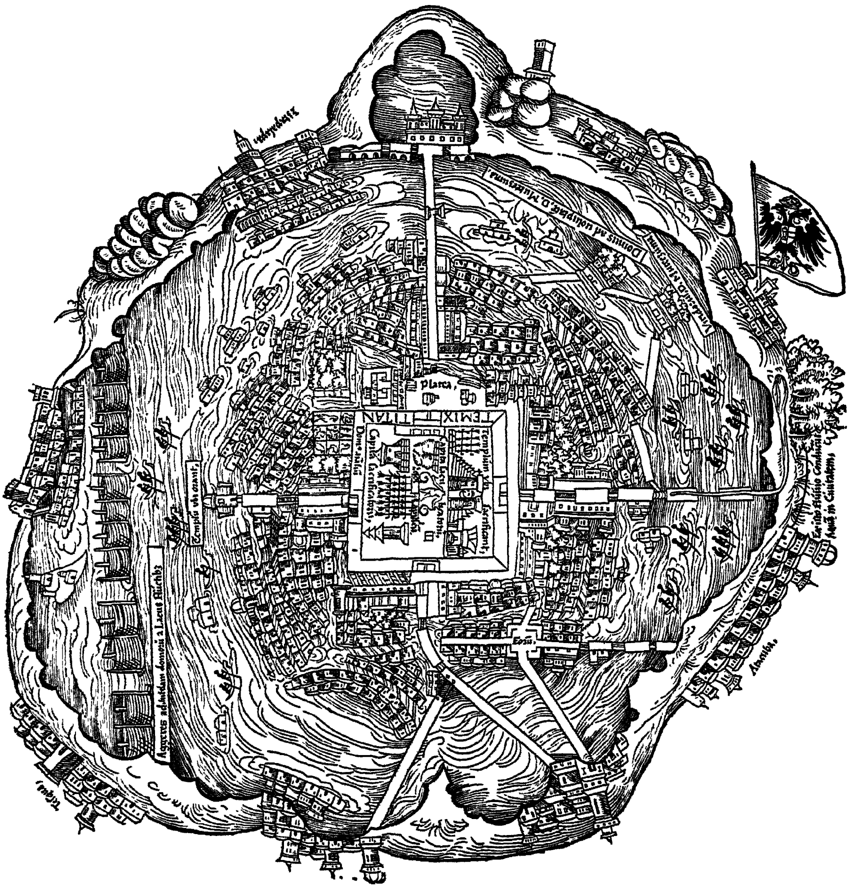

FIG. 1—The City of Mexico in 1524. Reproduced by permission from facsimile published in 1939 by the William L. Clements Library, University of Michigan.

Indians, "scattered without order . . . as is the ancient custom among them."[14]

Unfortunately there is no map of the native city of Tenochtitlán. The "Plano en papel de maguey" is not on maguey paper, nor has it, probably, any degree of accuracy as a plan. In any event, it is post-Conquest and probably of a time long after the destruction of the native city.[15] The earliest datable map is that published with Cortes' letters in Nuremberg (Fig. 1) in

[14] Francisco Cervantes de Salazar: México en 1554, Mexico, 1939, p. 95.

[15] Toussaint *et al.*, *op. cit.*, pp. 36 and 109.

1524.[16] If this could be depended on as a map of Tenochtitlán, it would indicate that the grid was certainly lacking. But probably it cannot be used as an indication of anything definite. Its author is unknown, and it has many shortcomings. It suggests the imagination of a European map maker far more strongly than a careful plan of the New World city.[17] From this map many others were copied, which have themselves become famous.[18] There are no others at present available that could be remotely suggested as offering a clue to the plan of the native city.

Tenochtitlán was approached on two, and probably three, sides by long, straight causeways. These led into the main temple square. On the fourth side was another causeway, which was not straight and which led into one corner of the square. The three straight causeways may have met the temple square at approximately right angles. However, two or three straight streets do not make a grid, nor does a rectangular compound or building necessarily induce people to think in terms of a grid plan for the rest of the city.

It is true that the causeways, in part at least, were incorporated into the later city of Mexico, but to think that they were basic to, and responsible for, the subsequent form is to overlook the fact that grids come into being only under special circumstances that have nothing to do with isolated straight streets or rectangular structures. These circumstances were present after the capture of the native Tenochtitlán by the Spaniards, and effectively perhaps for the first time after the Conquest.

Basic Conditions of Grid Plan

Briefly, the basic conditions are these: (1) a completely new city to be built (this was possible here because of the virtual effacement of the native city structures by the Spaniards in 1521); (2) the city planned as a unit according to preconceived specifications and pattern (here the often repeated instructions of the king could be carried into effect); (3) centralized control (witness Cortes' determination to rebuild the city on the site of the Aztec capital in spite of the opposition of many of his companions[19]); (4) the desire

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[16] *Ibid.*, Fig. 13.

[17] *Ibid.*, p. 109. Fernandez's conclusion that this map was made by a European is entirely reasonable, but his contention that it was made from a sketch sent by Cortes cannot be proved.

[18] For example, the map of "La gran cittá de Temistitan" in the "Libro di Benedetto Bordone nel qual si ragiona de tutte l'Isole del mondo," Venezia, 1528, Book 1, X. It is taken with some variations from the Nuremberg map. For a discussion of this see Toussaint *et al.*, *op cit.*, p. 101.

[19] Note the testimony of his companions in answer to question #37 in "Sumario de las residencia tomada a D. Fernando Cortés," in "Documentos para la historia de México," 2 vols., Archivo Mexicano, Mexico, 1852; also the "Carta del contador Rodrigo de Albornoz" to the king, D I I, Vol. 13, 1810, pp. 45–84, reference on pp. 76 ff. After Cortes' departure from Mexico City for his expedition into Central America, the attempt was again made to have the city moved from the ancient site to either Coyoacán or Texcoco.

for measured apportionment of property; (5) knowledge of the grid (a *sine qua non*).

Many new foundations had been established by the Spaniards before this time, and one or more of the above requirements had been met, but here, probably for the first time, they were all fulfilled. That the great temple square of the Aztec city and the fine, straight causeways fitted into the plan is manifest. This, however, was coincidental.

Not only were the necessary conditions present, but there were men available with training in the idea of the grid. Cortes ordered the planned rebuilding of the city in accordance with the earlier royal instructions and appointed a group of specially trained men to carry it out. One of these was the previously mentioned Alonso García Bravo, the "good geometer," who was seen walking through the site of the city, laying out straight streets and presumably using his knowledge of geometry to establish the rectangularity of the blocks and the size of the *solares* (house plots) within them.[20]

The matter of reward in land was of prime importance from the beginning of the plan. This factor, more than any other, had probably influenced the king in his earlier instructions, and certainly it had bearing on the decisions of Cortes.

After the planning and rebuilding of Mexico City, other cities were established in various parts of New Spain following the same plan. In 1528[21] Villa Real in Chiapas was founded. This followed the plan of measured streets and solares and apportionment of land according to merit, as ordered in the king's instructions.[22] Within three years another important city was founded—Puebla. It was as carefully "traced" as Mexico City and Villa Real de Chiapas, and the procedure regarding the apportionment of land

[20] "Información de los méritos y servicios de Hernando de la Serna, Melchor Suárez y Córdoba, Alonso García Bravo y Pedro de Castillar, hechos en el descubrimiento y conquista de Méjico y Nueva España por Hernán Cortés," in Archivo General de Indias, Patronato Real, Papeles de Simancas, T. 1. fol. 218, estante 1, caja 111, leg. 30/31, as cited in J. R. Benítez: Historia gráfica de la Nueva España, Mexico, 1929, p. 44; also Toussaint *et al.*, *op. cit.*, pp. 21 and 136.

[21] The often cited description of the foundation of Acámbaro in Michoacán, based on the document quoted by Beaumont (Pablo Beaumont: Crónica de Michoacán. 3 vols., Mexico, 1932; reference in Vol. 2, pp. 298 ff), cannot be accepted. The date given at the beginning of the document, 1526, is somewhat surprising in the light of the history of Michoacán. But more than this, the same document a few pages later specifically states that Acámbaro was the last of a trio of towns to be founded, the first having been Querétaro and the second Apaseo. If this statement is true, the date 1526 is clearly impossible; for Querétaro was in the "Gran Chichimeca," and there were no foundations as far north as that for years after this date. Also, the document states that the foundation was approved by the *Real Audiencia*. The first *audiencia* in Mexico had not been established in 1526.

[22] Antonio de Remesal: Historia general de las Indias Occidentales, y particular de la gobernación de Chiapa y Guatemala (Biblioteca "Goathemala," Vols. 4 and 5), 2nd edit., 2 vols., Sociedad de Geografía e Historia, Guatemala, 1932, reference in Book 5, pp. 382–402.

was as precise as those of the earlier foundations.[23] From that time on, settlements founded by the Spaniards were typically of this form. (Indian towns also were sometimes so planned.)

DEPENDENCE UPON PLANS OF VITRUVIUS

There is an obvious similarity of detail between the Roman (Vitruvius') plans and the instructions of the Spanish kings, at least those dating from 1513, when Ferdinand sent them to Pedrarias Dávila. As the years passed, the dependence on ancient practice became even more noticeable. For example, Echeverría y Veytia gives the proportions of the plaza in the newly established Puebla as 128 varas by 217, which would virtually fulfill Vitruvius' instructions that the width should be two-thirds of the length. Precise measurements were probably sacrificed to the desire to apportion the solares in units measured by simple round numbers. Echeverría y Veytia describes the solares as being 50 varas in width by 100 varas in length. If the size of the solar was of first importance, then, unless the streets were to be wider than anything in Spanish or New World practice of the period, the plaza could not conform exactly to the proportions given by Vitruvius. It must be pointed out also that there is some discrepancy in the figures of Echeverría y Veytia; for if the solares met his figures and the streets likewise (in width), the plaza would not fit into the proportions he gives for it.

In any event, the figures are close enough to the specifications of early Roman practice to indicate their relationship. And the blocks face with their angles to the cardinal points, as demanded by the Roman plans.

As a bit of more direct evidence, there is the copy of Vitruvius printed in 1550 known to have been in the possession of one of the architects of Mexico City.[24] It cannot reasonably be doubted that there were earlier editions of Vitruvius in use in Mexico. Cervantes de Salazar, trained in Spain, mentions Vitruvius as if he were the oracle to whom planners turned in the mid-sixteenth century.

In 1573, Philip II sent out codified instructions, far more comprehensive than any earlier ones. They probably contained nothing new, however; for they were obviously made up of the long series of earlier orders to the founders of towns in New Spain. In their greater coverage they show even more strongly their dependence on ancient sources, especially Vitruvius.

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[23] M. F. Echeverría y Veytia: Historia de la fundación de la ciudad de la Puebla de los Angeles, Mexico, 1931, pp. 101, 139–140. 201, 211, and 216–218.

[24] Manuel Toussaint, J. R. Benítez, and Dr. Atl: Iglesias de México, 6 vols., Mexico, 1927; reference on p. 71.

For this reason it may be of value to quote comparable paragraphs from each.[25]

VITRUVIUS	PHILIP II
I cannot too strongly insist upon the need of a return to the method of old times. Our ancestors, when about to build a town or an army post, sacrificed some of the cattle that were wont to feed on the site proposed and examined their livers. If the livers of the first victims were dark-coloured or abnormal, they sacrificed others, to see whether the fault was due to disease or their food. They never began to build defensive works in a place until after they had made many such trials and satisfied themselves that good water and food had made the liver sound and firm.	In selecting the province, region, and area that is to be settled, always keep in mind that it should be healthful, which can be known by the number of healthy old people and youths of good constitution and color, and by the number of healthy animals of good size, and by the healthy fruits and other provisions.
For fortified towns the following general principles are to be observed. First comes the choice of a very healthy site. Such a site will be high, neither misty nor frosty, and in a climate neither hot nor cold, but temperate; further, without marshes in the neighbourhood. For when the morning breezes blow toward the town at sunrise, if they bring with them mists from marshes and, mingled with the mist, the poisonous breath of the creatures of the marshes to be wafted into the bodies of the inhabitants, they will make the site unhealthy. Again, if the town is on the coast with a southern or western[26] exposure, it will not be healthy, because in summer the southern sky grows hot at sunrise and is fiery at noon, while a western exposure grows warm after sunrise, is hot at noon, and at evening all aglow. These variations in heat and the subsequent cooling off are harmful to the people living on such sites.	Do not select the places of great elevation, since the winds are bothersome, and the service and transport are difficult, or very low places, for they are usually insalubrious; select places of intermediate elevation that enjoy fresh air—especially coming from the north and south—and if there are mountains or hills near the site, they should be to the east or to the west, and if for some reason a place of considerable elevation must be chosen, see to it that it is in a place that is not subjected to fogs; if the site is by a river, it should be placed to the east, so that the rising sun touches first upon the town before it touches the water.[27]
After insuring on these principles the healthfulness of the future city, and selecting a neighbourhood that can supply plenty of food stuffs to maintain the community,	Having selected the site for the town, it must be in an elevated place, where there are healthy conditions, protection, and fertile lands for farming and pastures, fuel

[25] For these instructions see Vitruvius: The Ten Books on Architecture, translated by M. H. Morgan, Cambridge and London, 1914, and "Fundación de pueblos en el siglo XVI," *Bol. Archivo Generál de la Nación*, Vol. 6, No. 3, Mexico, 1935, pp. 321–360.

[26] This is not in keeping with the Greek practice, which favored the southern and western slopes. The exposure of Greek cities may reasonably be explained in terms of prevailing winds.

[27] The Spaniards seem here to favor the Greek usage, and not that suggested by Vitruvius.

with good roads or else convenient rivers or seaports affording easy means of transport to the city, the next thing to do is to lay the foundations for the towers and walls.

and building materials, good water, natives, convenience of transport, of easy access, open to the north wind. If it be on the coast, care should be taken that it be a good harbor and that the sea should be neither to the south nor to the west; if this is not possible, do not place it near lagoons or swamps in which are poisonous animals and polluted air and water.

. . . Let the directions of your streets and alleys be laid down on the lines of division between the quarters of two winds.

On this principle of arrangement the disagreeable force of the winds will be shut out from dwellings and lines of houses. For if the streets run full in the face of the winds, their constant blasts rushing in from the open country, and then confined by narrow alleys, will sweep through them with great violence. The lines of houses must therefore be directed away from the quarters from which the winds blow, so that as they come in they may strike against the angles of the blocks and their force thus be broken and dispersed.

. . . The four corners of the plaza face to the four principal winds, because in this way the streets leaving the plaza are not exposed to the principal winds, which would be of great inconvenience.

The size of a forum should be proportionate to the number of inhabitants, so that it may not be too small a space to be useful, nor look like a desert waste for lack of population. To determine its breadth, divide its length into three parts and assign two of them to the breadth. Its shape will then be oblong, and its ground plan conveniently suited to the conditions of shows.

The plaza should be a rectangle, prolonged so that the length is at least half again as long as the width, because this form is best for celebrations with horses, and for any others that are to take place.

The size of the plaza should be proportionate to the population, taking into consideration that in Indian towns, since they are new and intended to increase, the plaza should be designed with such increase in mind. It should not be less than two hundred feet in width and three hundred feet in length, nor greater than eight hundred feet in length and five hundred and thirty-two in width; a good proportion is the intermediate size of six hundred feet in length and four hundred in width.

The Greeks lay out their forums in the form of a square surrounded by very spacious double colonnades, adorn them with columns set rather closely together, and with entablatures of stone or marble, and construct walks above in the upper story. But in the cities of Italy the same method cannot be followed, for the reason that it is a

All around the plaza and the four principal streets that start from it there should be colonnades because of the great convenience that they offer to the merchants who gather here; the eight streets that leave from the four corners of the plaza are not to have colonnades that would block their juncture with the plaza.

custom handed down from our ancestors that gladiatorial shows should be given in the forum.

Therefore let the intercolumniations round the show place be pretty wide.

Basilicas should be constructed on a site adjoining the forum and in the warmest possible quarter, so that in winter business men may gather in them without being troubled by the weather.

. . . If the city is on the sea, we should choose ground close to the harbour as the place where the forum is to be built; but if inland, in the middle of the town.	If the town is a port, the main plaza should be at the harbor (*desembarcadero*). It should be in the middle of the town in inland places.
Having laid out the alleys and determined the streets, we have next to treat of the choice of building sites for temples, the forum, and all other public places, with a view to general convenience and utility.	For the cathedral, parish church, or monastery there is to be the first assignment of *solares* after the streets and plazas are laid out. Then mark out the places for the palace, the town hall, the customs house, and the arsenal.[28]
. . . For the temples, the sites for those of the gods under whose particular protection the state is thought to rest and for Jupiter, Juno, and Minerva, should be on the very highest point commanding a view of the greater part of the city. The treasury, prison, and senate house ought to adjoin the forum, but in such a way that their dimensions may be proportionate to those of the forum.	The cathedral of inland places should not be placed at the plaza, but at some distance . . . and so that it can be seen from all sides, because it lends greater adornment and authority, and arrange it in such fashion that it is raised above the ground level so that it will be approached by steps. Near it on the main plaza the palace, the town hall, and customs house should be built so that they do not detract from the cathedral but give it greater importance.

There has been a commonly expressed belief that the town planning of New Spain was an outcome of rule-of-thumb practice in the New World, which set up the grid in "spontaneous fashion." According to this theory, a satisfactory method of meeting the problem was achieved by the provincials and then was recognized and given official status by royal authority. Quite the contrary is true. The codification in the reign of Philip II shows the almost complete dependence of the Spaniards on Roman and Greek experience. That this dependence dates from the earliest attempts of Spain to establish planned settlements in the New World is shown by the obvious derivation of the earliest Spanish instructions from Roman and Greek sources. Whatever the qualities of Spanish genius, the experience and

[28] The only addition made by the Spaniards to the original Roman instructions concerned an arsenal. This had come into greater importance than at the time of Vitruvius.

knowledge necessary for successful town planning were lacking. Instead of showing a capacity for improvisation, the Spaniards turned (as had the peoples of other Western European nations) to early Mediterranean practices and followed them almost slavishly.

It is not to their discredit that they did so. The grid and the details within it established by the earlier peoples had proved their usefulness. The grid served Spanish purposes no less well than it had those of the Romans, the Greeks, the Mesopotamians, and the inhabitants of the Indus Valley before them. It may not have all the esthetic qualities that we demand at present, but as a generic plan to fit the needs of unknown sites, and for the purpose of distribution of property, there may be none better.

PRECIPITATION SEASONS IN THE UNITED STATES

STEPHEN S. VISHER

FOUR parts of the United States have well marked seasonal contrasts in total precipitation (Fig. 1). The contrast is greatest on the Pacific coast. There the winters are rainy, but in midsummer almost no rain is to be expected in Washington or during more than six months in central California. Much of southern California normally receives no rain at all during seven summer weeks. The northern Great Plains receives very little precipitation in winter but nearly an inch a week during part of the summer. Florida and a part of the Southwest also receive several times as much rain in summer as in winter.

In addition to seasonal contrasts in total precipitation, there are contrasts in type. Figure 13 shows the regions that have sharply contrasting amounts of snowfall; Figure 14 indicates where "excessive" rainfalls occur often enough to be characteristic; and Figure 19 shows the regions where hail is relatively frequent.

For each of these types of precipitation the distribution and duration of the major subtypes is indicated on Figures 2, 3, 12, 14, 19, and 23. The average dates of the beginning and end of each of the precipitation seasons are presented on the remaining maps of the series.

The data for the seasons of total precipitation were derived from "Average Precipitation in the United States, 1906 to 1935 Inclusive," by W. F. McDonald, United States Weather Bureau, 1944 (mimeographed), which is based on the records for 1747 stations, mapped for each week of the year.

Part of the data on snowfall was derived from the weekly snow-cover maps for 1932–1945 published in the *Weekly Weather and Crop Bulletin* of the United States Weather Bureau. However, Figure 9, the date of the first measurable snowfall, is an adaptation of Kincer's map in the "Atlas of American Agriculture," and Figure 12, the average number of days with snow cover, is after Kincer's map in the 1941 *Yearbook of Agriculture* of the United States Department of Agriculture. The maps on hail were derived from the monthly maps by Hoyt Lemons in the *Geographical Review* for July, 1942, which are based on official data for 40 years. The maps on "excessive" rains were derived from monthly maps in Yarnell's "Rainfall Intensity-Frequency Data" (*U. S. Dept. of Agric. Misc. Publ. No. 204,* 1935), which are based on the records for 30 years—more than 250 first-order stations.

Many of the data on which the accompanying maps are based have been assembled only recently and have greatly facilitated delimitation of the

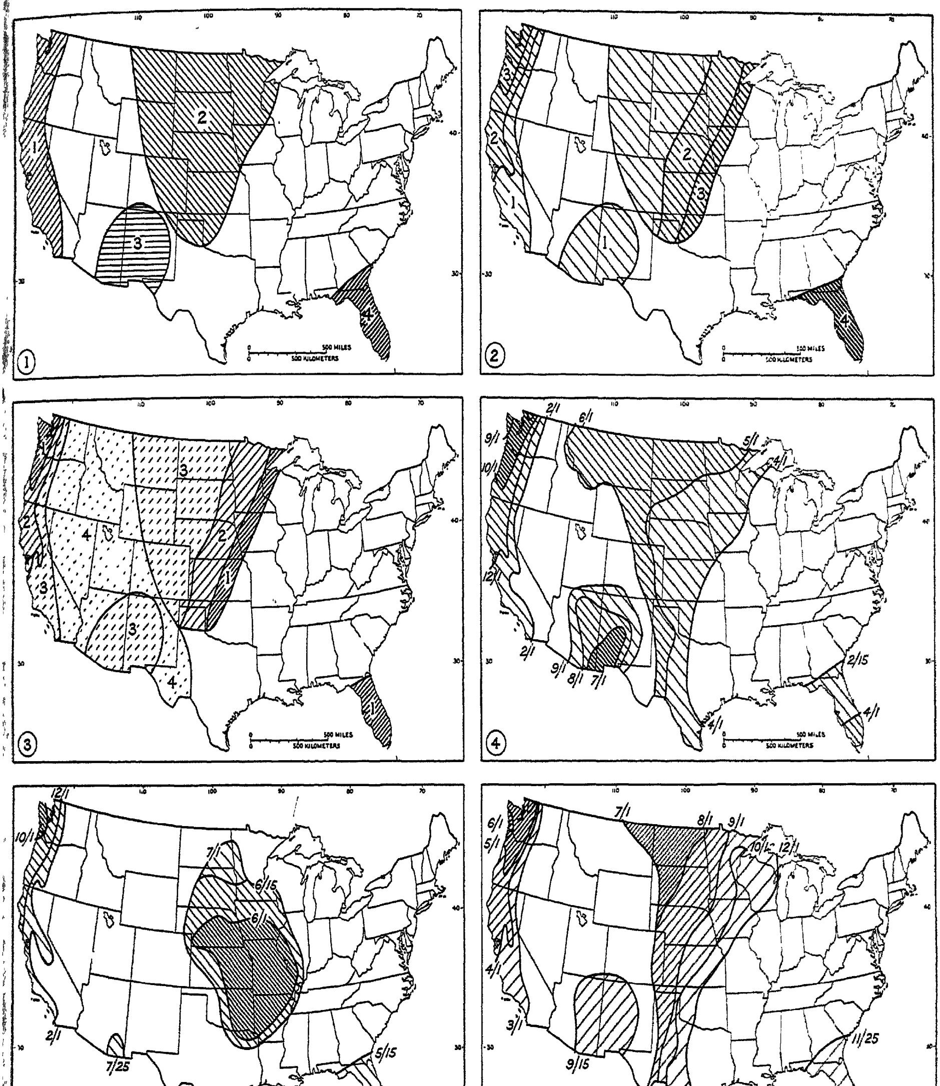


FIG. 1—Areas with conspicuous seasonal contrasts in total precipitation: 1, dry in summer; 2, dry in winter; 3, dry except for part of summer; 4, much wetter in summer than in winter.

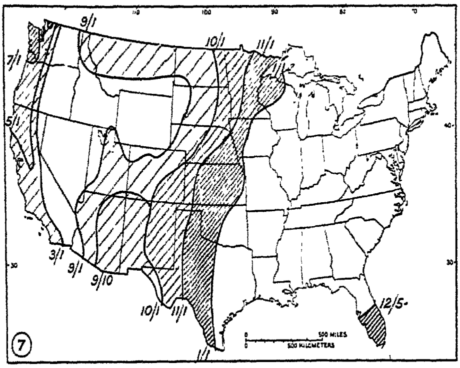
FIG. 2—Average length of the relatively wet season (weekly normals of 0.5 inch or more): 1, 1–3 months; 2, 4–6 months; 3, 7–10 months; 4, more than 1 inch a week for 5 months, much of it more than 2 inches a week for at least 6 weeks.

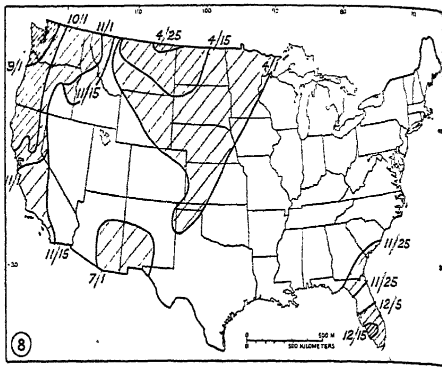
FIG. 3—Average length of the relatively dry season (weekly normals of less than 0.5 inch): 1, 2–5 months; 2, 6 or 7 months; 3, 8–10 months; 4, 11 or 12 months.

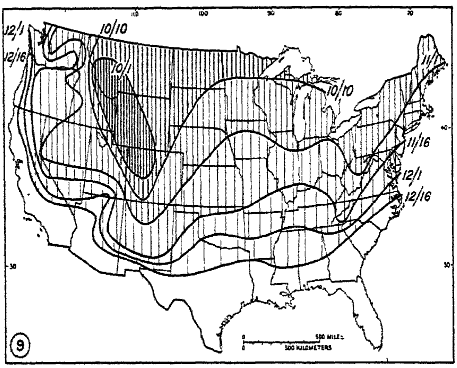
FIG. 4—Date when the rainy season normally begins (weekly normals exceed 0.5 inch). The western unshaded areas do not have weekly normals of 0.5 inch, the eastern ones generally do.

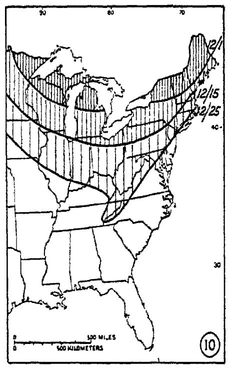
FIG. 5—Date when the wetter season normally becomes distinctly wet (weekly normals exceed 1 inch). The western unshaded area does not have weekly normals of 1 inch; the eastern one has them irregularly.

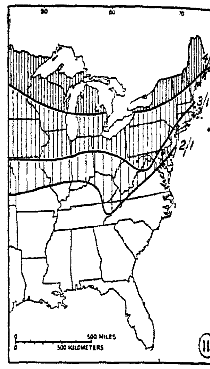
FIG. 6—Date when the dry season normally begins (weekly normals become less than 0.5 inch). The western unshaded area frequently has normals less than 0.5 inch; the eastern area, rarely.

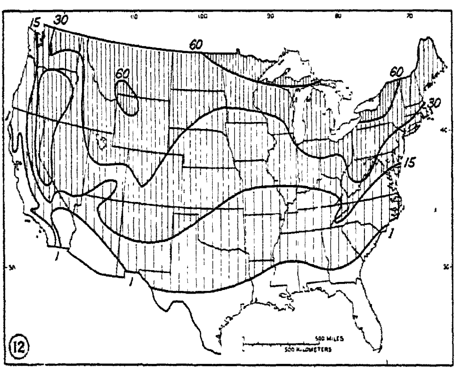












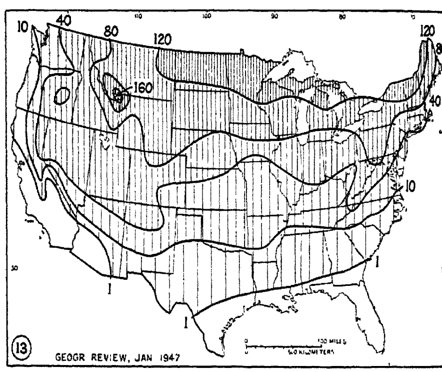


FIG. 7—Date when the dry season normally is pronounced (weekly normals become less than 0.25 inch).

FIG. 8—Date when the distinctly dry season (less than 0.25 inch) ends. Season with no rain normally ends in southwestern California about August 23.

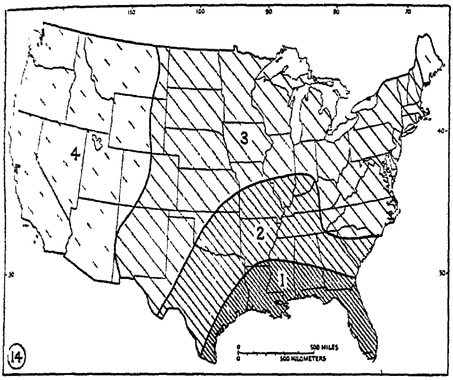
FIG. 9—Average date of first measurable snowfall (0.1 inch or more).

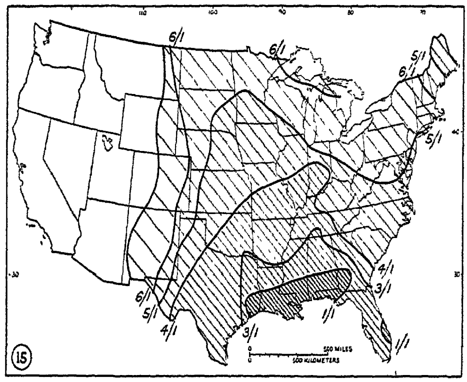
FIG. 10—Average date when 3 inches of snow first covers the ground.

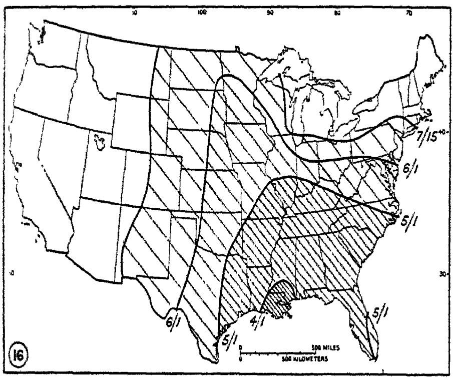
FIG. 11—Average date after which the ground is not covered with snow.

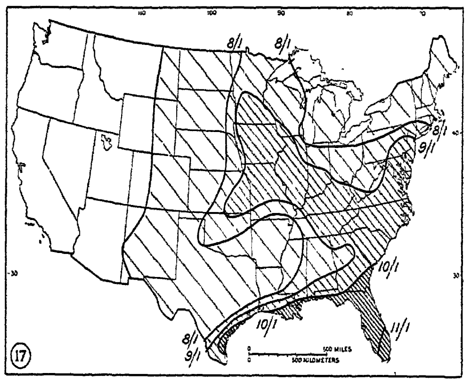
FIG. 12—Average annual number of days with measurable snowfall (0.1 inch or more).

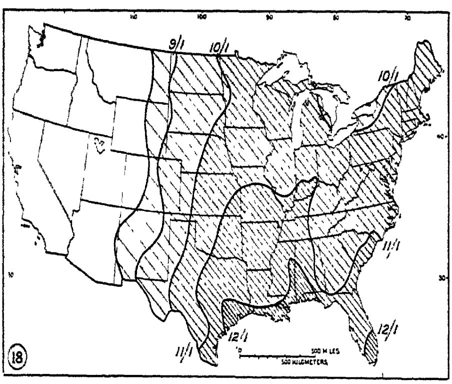
FIG. 13—Average annual number of days with a snow cover of 1 inch or more. These days are not necessarily consecutive.











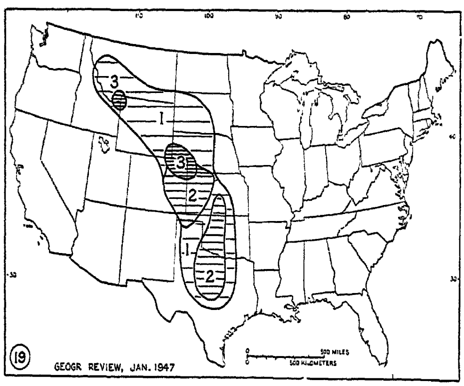


FIG. 14—Seasonal distribution of excessive rains: 1, during 9 months or more; 2, 6–8 months; 3, occasional in summer; 4, lacking or very rare. ("Excessive" rains are vaguely defined but include 1 inch in an hour, 1.5 inches in 2 hours.)

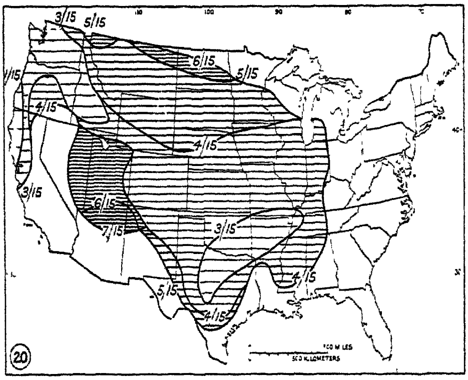
FIG. 15—Approximate beginning date of season with at least occasional excessive rains (over a period of 30 years excessive rains occurred only 10 times in the months indicated).

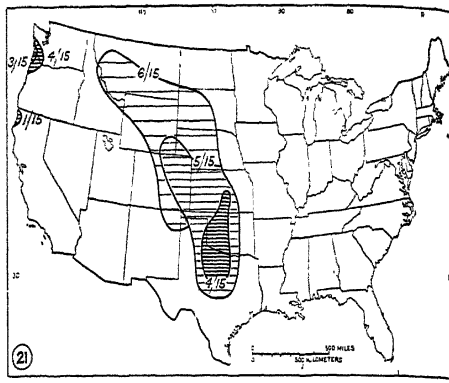
FIG. 16—Approximate beginning date of season with frequent excessive rains (averaging more than 1 a month).

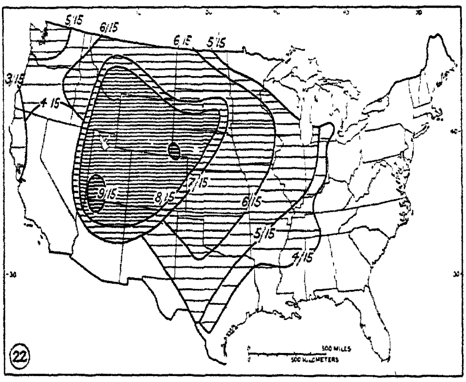
FIG. 17—Approximate ending date of season with frequent excessive rains.

FIG. 18—Approximate ending date of season with occasional excessive rains.

FIG. 19—Average length of season having 1 or more hailstorms a month: 1, less than 1 month; 2, 1 or 2 months; 3, 3 or 4 months.







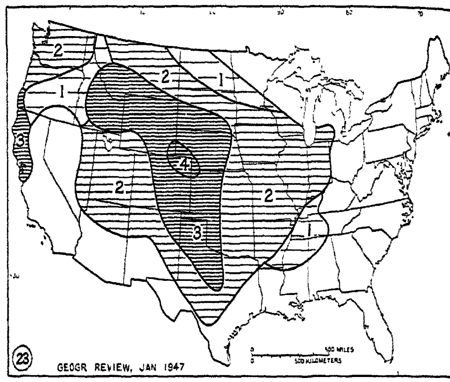


FIG. 20—Average beginning date of season with at least occasional hailstorms.

FIG. 21—Average date when hailstorms become relatively frequent (1 or more a month).

FIG. 22—Average date when hailstorms become rare.

FIG. 23—Average length of season with hailstorms (very rare in other months): 1, less than 1 month; 2, 1 month; 3, 2 or 3 months; 4, 4 or 5 months.

precipitation seasons. Comparable regionalization has not been done previously.

The great significance of many of the seasonal contrasts here mapped is widely recognized and need not be elaborated on. Mention may be made, however, of a few consequences. The fact that Florida in winter is relatively dry as well as sunny and warm is highly favorable for the winter tourist business. The southwestern area, mostly New Mexico, which has considerable summer rainfall, is able to grow corn far more successfully than most of the West; this fact favored the development in that area of early Indian cultures based on corn. The Cliff Dwellers and Hopi, with their permanent settlements, were more advanced culturally than the Indians of other dry western areas, where corn growing was not feasible. In the large north-central plains area the dry winter has favored stock raising, partly because

much of the grass normally cures to natural hay and seldom is snow-covered too deeply to prevent winter grazing. Conversely, the usually considerable rainfall of late spring and early summer permits much crop production, except in dry years. In California the almost rainless summer of much of the state is conducive to the drying of fruit and encourages the practice of irrigation. On the Pacific coast the dry summers are much less harmful to evergreen conifers, with their quick vegetative growth in spring, than to deciduous trees, which do most of their growing in summer. This fact helps to explain the type of Pacific forest. "Excessive" rainfalls are unfortunately relatively numerous in a region where prolonged heavy rains and much rainfall during the cooler months lead to soil erosion, which is the greater because of the extensive cultivation of row crops, especially corn, cotton, tobacco, peanuts, and vegetables. A correspondence between the seriousness of soil erosion and the intensity of rainfall is obvious.[1] The regional distribution of frequent hailstorms is, fortunately, favorable, in that hail is comparatively common in a region otherwise relatively ill-suited to fruit production. The chief fruit-growing regions normally have little hail in summer.

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[1] S. S. Visher: Torrential Rains as a Serious Handicap in the South, *Geogr. Rev.*, Vol. 31, 1941, pp. 644–652; *idem:* Regional Contrasts in Torrential Rainfalls Help to Explain Regional Contrasts in Erosion, *Journ. of Geol.*, Vol. 50, 1942, pp. 96–105; *idem:* Climate of Indiana, *Indiana Univ. Publs., Science Ser. No. 13*, Bloomington, Ind., 1944.

THE MANIPULATION OF PROJECTIONS FOR WORLD MAPS*

EDWARD J. BAAR

THE numerous forms of map projections, so confusing to the layman, have been classified by various authorities according to their different properties. Some are equal-area, for example; others are conformal. In most cases there is no standard basis of comparison. Many are difficult to compute, and their existing tables are seldom comparable.

In this paper groups of projections are discussed which have as their common characteristic the representation of lines of equal latitude as concentric circles or as straight parallel lines, the latter being, of course, only a special case of the former. Simple relationships are disclosed, which permit easy classification and tabulation. A general equation for the spacing of the parallels of latitude in these groups is given, from which may be derived, as special cases, a number of projections that are already familiar and unlimited series of others. The projections within each series are, in general, easy to compute.

Preface to Study

In the *Geographical Journal* of March, 1929,[1] Mr. S. Whittemore Boggs of the United States Department of State described his "eumorphic" projection, which is an arithmetical mean between the sinusoidal and Mollweide equal-area projections. In the same journal, in November, 1929,[2] Lieutenant Colonel J. E. E. Craster set forth descriptions and tables for the construction of a series of projections based on geometric curves and calculable in his notation only through the use of Cartesian coordinates. These projections bridge in an orderly manner the gap between the sinusoidal and Mollweide projections.

Messrs. Charles H. Deetz and Oscar S. Adams of the United States Coast and Geodetic Survey, who assisted Mr. Boggs in the preparation of his eumorphic projection, were quick to seize on the Craster series, chose what appeared to them to be the most desirable graticule of the lot, the

* Grateful acknowledgment is due Mr. Robert Singleton for his constructive review of the substance of this article. As a result, in order to give primary emphasis to the general relationships revealed, the material has been reorganized, with the author's full approval, by changing the order of presentation, by introducing a more comprehensive system of notation, and by slight amplification.—Edit. Note.

[1] S. W. Boggs: A New Equal-Area Projection for World Maps, *Geogr. Journ.*, Vol. 73, 1929, pp. 241–245.

[2] J. E. E. Craster: Some Equal-Area Projections of the Sphere, *Geogr. Journ.*, Vol. 74, 1929, pp. 471–474.

parabolic, and developed a simple trigonometrical formula for its construction.[3]

Mr. Boggs's suggestion to produce a cylindrical map of the world for popular use that would strike an acceptable balance between shape and area distortion led Mr. O. M. Miller of the American Geographical Society to modify or, rather, to generalize the Mercator-projection formula.[4] The equation describing this generalization is a special case of the general equation which is discussed below.

A General Equation for the Spacing of Parallels

Let α, β be a general system of coordinates on the map plane, ω be the difference in latitude (ϕ) between a specified central parallel of latitude and any other, and λ be the difference in longitude between the central meridian of the projection and any other. Then, if the radius of the projected sphere is assumed to be unity, the general mapping equation which we wish to study is

$$\alpha = M + \frac{1}{Ka} f(a\omega); \qquad \beta = g(\lambda\omega), \tag{1}$$

where K, M, and a are arbitrarily assumed constants, and $f(a\omega)$ and $g(\lambda\omega)$ are arbitrarily assumed functions of $(a\omega)$ and $(\lambda\omega)$ respectively.

Limiting the discussion here to polar and Cartesian coordinate systems, we derive the general polar coordinate form by making $\alpha = r$, the radius vector, and $\beta = \theta$, the amplitude. In this case if M is zero and $\omega = \chi$ (the colatitude) and $g(\lambda\chi) = \lambda$, we obtain an expression for a type of polar azimuthal projection:

$$r = \frac{1}{Ka} f(a\chi); \qquad \theta = \lambda. \tag{2}$$

The general Cartesian coordinate form is derived from (1) by making $\alpha = y$ and $\beta = x$. If the origin of the system is on the equator, the $+Y$ direction is north, and M is zero, ω becomes the latitude (ϕ) and we obtain an expression for a type of projection on which the lines of equal latitude are shown as straight parallel lines:

$$y = \frac{1}{Ka} f(a\phi); \qquad x = g(\lambda\phi). \tag{3}$$

Finally, as a special case of (3), if we make $g(\lambda\phi)$ independent of ϕ, we obtain an expression for a cylindrical type of projection.

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[3] C. H. Deetz and O. S. Adams: Elements of Map Projection, *U. S. Coast and Geodetic Survey Special Publ. No. 68,* 3rd edit., 1931, pp. 165–168.

[4] O. M. Miller: Notes on Cylindrical World Map Projections, *Geogr. Rev.*, Vol. 32, 1942, pp. 424–430

THE LOG$_e$ TANGENT AND THE TANGENT SERIES

As preliminary examples of the use of the general equation we employ the $\log_e$ tangent and the tangent functions as applied to cylindrical maps. In the notation used here the Miller generalization of the Mercator formula is written

$$(4) \qquad y = \frac{1}{Ka} \log_e \tan \left(\frac{\pi}{4} + \frac{a\phi}{2} \right); \qquad x = \lambda.$$

When $K=1$ the equator is true to scale. When $K=a=1$ the Mercator projection results. In order to produce a projection approximately the same in over-all shape as Gall's cylindrical, the value adopted for K is 1 and for a is 0.8.

The function of the tangent may be similarily employed:

$$(5) \qquad y = \frac{1}{Ka} \tan (a\phi); \qquad x = \lambda.$$

When $K=a=1$, the central or perspective cylindrical projection results. To make the over-all proportions similar to those of the Gall and Miller projections, the value of a should be about 0.6. This projection, as compared with the Miller projection, reduces the compression in middle latitudes, which, in the writer's opinion, is extremely desirable.

Employing A. E. Young's[5] criteria of true total area and true total depth as the best proportions for a cylindrical map, we arrive at the following, as illustrated in Figure 1:

$$(6) \qquad y = \frac{2}{\pi} \left(\frac{1}{0.6411} \right) \tan (0.6411\ \phi); \qquad x = \frac{2}{\pi} \lambda.$$

As another preliminary example of the use of the general equation we apply the tangent function to the polar azimuthal type:

$$(7) \qquad r = \frac{1}{Ka} \tan (a\chi); \qquad \theta = \lambda.$$

Thus, for example, when $K=a=1$ the gnomonic projection results. When $K=1$ and $a=0.5$ the stereographic projection results, and when $K=1$ and $a=0.25$ Breusing's harmonic projection is obtained. Young[6] shows that by making K a suitable function of the limiting colatitude this last projection can be made to have practically minimum error for azimuthal projections.

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[5] A. E. Young: Some Investigations in the Theory of Map Projections, *Royal Geogr. Soc. Technical Ser. No. 1*, 1920.

[6] *Ibid.*

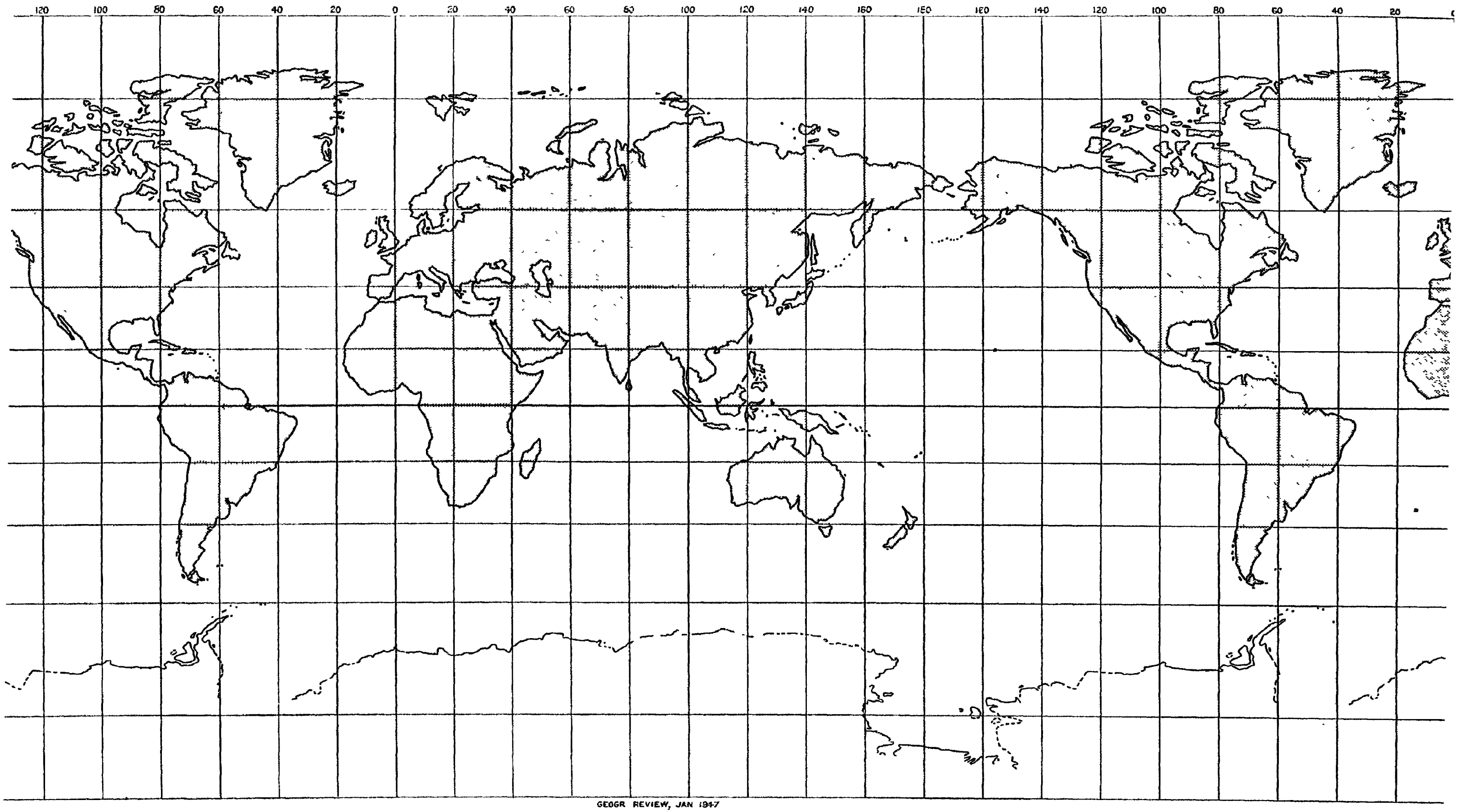


FIG. 1—A sketch map on a cylindrical projection in the tangent series. $a = 0.6411$, $K = 2/\pi$, $x = 2\lambda/\pi$. This projection is neither equal-area nor conformal. Compare with illustration of the Miller cylindrical in the *Geographical Review* (Vol. 32, 1942, p. 426).

The Sine Series

The sine series in the polar azimuthal type is

(8) $$r = \frac{1}{Ka} \sin (a\chi); \qquad \theta = \lambda.$$

If $K = a = 1$ the orthographic is obtained. If $K = 1$ and $a = 0.5$ the Lambert polar azimuthal is produced.

Also in the sine series, equation (3) becomes

(9) $$y = \frac{1}{Ka} \sin (a\phi); \qquad x = g\,(\lambda\phi).$$

In this group, if $a = 1$ and $x = K\lambda$ the general expression for the cylindrical equal-area projection is obtained with two standard parallels where K is the cosine of the standard parallel. Obviously, if $K = a = 1$ the equator becomes the standard parallel.

The cylindrical equal-area projection, which Craster[7] describes as the limit of his hyperbolic series, can be produced by making the distance from equator to pole equal to 90° on the equator. For this projection $K = \sqrt{2/\pi} =$ cosine 37° 04′.

In the sine series as expressed in the formula for y in (9), if $a \neq 1$ the projection will not be equal-area unless the expression for x takes the form[8]

(10) $$x = \lambda \cos \phi \Big/ \frac{\delta y}{\delta \phi}.$$

Consequently the general equation for the sine series of equal-area projections having straight-line parallels is

(11) $$y = \frac{1}{Ka} \sin (a\phi); \qquad x = \frac{\lambda K \cos \phi}{\cos (a\phi)}.$$

In the sine series, if a polar coordinate system is used the general equation (1) becomes

(12) $$r = M + \frac{1}{Ka} \sin (a\omega); \qquad \theta = g\,(\lambda\omega).$$

The general equation for equal-area projections in this series is[9]

(13) $$r = M + \frac{1}{Ka} \sin (a\omega); \qquad \theta = \frac{\lambda K \cos \phi}{r \cos (a\omega)}.$$

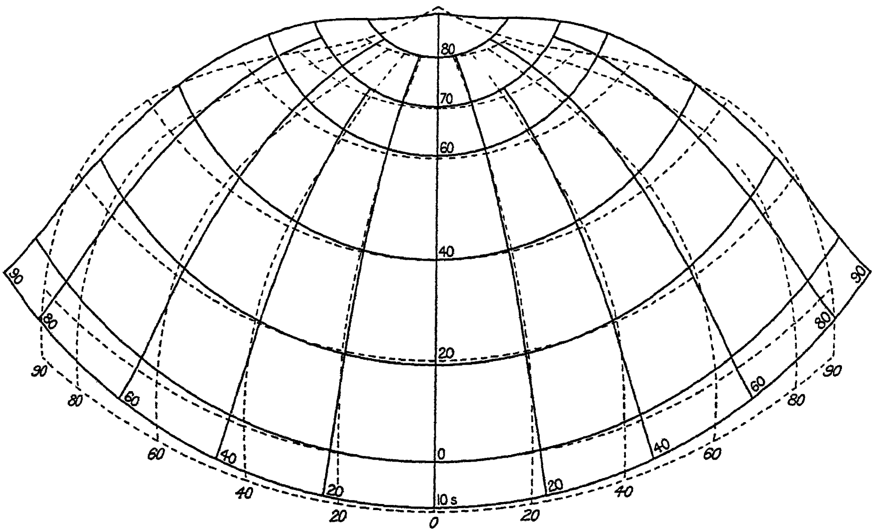
[7] *Op. cit.*

[8] For a proof of expression (10) see, for instance, R. K. Melluish: An Introduction to the Mathematics of Map Projections, Cambridge, England, 1931, pp. 27–30. Expression (10) is the special case when y is independent of λ. In general the equal-area condition is

$$\frac{\delta x}{\delta \phi}\frac{\delta y}{\delta \lambda} - \frac{\delta x}{\delta \lambda}\frac{\delta y}{\delta \phi} = \pm \cos \phi.$$

[9] That projections in the series represented by expression (13) are all equal-area can be readily checked by means of the general equal-area condition by first making the usual transformation from polar into Cartesian coordinates (see footnote 8).

If $K=1$ and M is the cotangent of the central parallel of latitude, a group of projections resembling Bonne's projection is derived. If $K \neq 1$, regardless of the value of M, the projections have two standard parallels. K is the cosine $(a\omega)$ of the standard parallels in all cases. Several examples of this group have been computed and drawn. One of these superimposed on a similar Bonne projection is illustrated in Figure 2.



GEOGR REVIEW, JAN 1947

Fig. 2—Comparison between a Bonne equal-area projection centered at latitude 40° (broken line) and an equal-area projection in the sine series (solid line) centered at latitude 40° with standard parallels at approximately 17° and 63° N., having $a=2/3$, $K=0.9643$, and $M=0.8320$ cot. 40°. If M were cotangent 40°, the center of the radii of the two projections would be the same point.

It would appear that, by suitable selection of constants within this easily computed group, the angular distortion can be made less than in the Bonne type and that it therefore forms a useful series for the equal-area mapping of large areas, for which we now have, among others, the Bonne, with great angular distortion; the Lambert oblique azimuthal, having quartic curves for both meridians and parallels; and the Albers conical, with two standard parallels and straight meridians, the very straightness of which produces unpleasant distortion when great distances on meridians are required.

Simplicity in Tabulation

In equation (11), by varying a between the limits 0 and 1 a series of equal-area projections is formed whose characteristics change from the sinusoidal to the equal-area cylindrical. In this range are produced the parabolic of Craster and other projections closely resembling in general form the Boggs

TABLE I—VALUES OF $\frac{\sin (a\phi)}{\sin (a\pi/2)}$ FOR OBTAINING DISTANCES OF PARALLELS FROM THE EQUATOR

ϕ	Sinusoidal	$a=1/4$	$a=1/3$	$a=1/2$	Eumorphic	$a=2/3$	Mollweide	$a=3/4$	$a=1$
0°	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10°	0.11111	0.11425	0.11629	0.12326	0.12328	0.13405	0.13681	0.14128	0.17365
20°	0.22222	0.22775	0.23219	0.24558	0.24581	0.26629	0.27202	0.28014	0.34202
30°	0.33333	0.34108	0.34730	0.36603	0.36680	0.39484	0.40397	0.41421	0.50000
40°	0.44444	0.45376	0.46123	0.48369	0.48544	0.51823	0.53097	0.54120	0.64279
50°	0.55556	0.56558	0.57361	0.59767	0.60085	0.63452	0.65116	0.65892	0.76604
60°	0.66667	0.67633	0.68404	0.70711	0.71202	0.74223	0.76239	0.76537	0.86603
70°	0.77778	0.78580	0.79216	0.81116	0.81764	0.83990	0.86191	0.85872	0.93969
80°	0.88889	0.89374	0.89760	0.90904	0.91566	0.92621	0.94540	0.93738	0.98481
90°	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000

TABLE II—VALUES OF SEC $(a\phi)$ COS ϕ FOR OBTAINING SPACING OF MERIDIANS

ϕ	Sinusoidal	$a=1/4$	$a=1/3$	$a=1/2$	Eumorphic	$a=2/3$	Mollweide	$a=3/4$	$a=1$
0°	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000
10°	0.98481	0.98575	0.98648	0.98857	0.98787	0.99151	0.99060	0.99331	1.00000
20°	0.93969	0.94328	0.94609	0.95419	0.95145	0.96572	0.96229	0.97284	1.00000
30°	0.86603	0.87350	0.87939	0.89658	0.89101	0.92160	0.91477	0.93738	1.00000
40°	0.76604	0.77786	0.78727	0.81524	0.80680	0.85723	0.84739	0.88425	1.00000
50°	0.64279	0.65839	0.67098	0.70924	0.69909	0.76936	0.75894	0.81022	1.00000
60°	0.50000	0.51764	0.53209	0.57735	0.56795	0.65270	0.64712	0.70711	1.00000
70°	0.34202	0.35862	0.37248	0.41753	0.40331	0.49840	0.50706	0.56183	1.00000
80°	0.17365	0.18479	0.19432	0.22668	0.22968	0.29086	0.32592	0.34730	1.00000
90°	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.00000

eumorphic and the Mollweide. Figure 3 is one of these projections in which the factor a has been chosen close to its cylindrical limit. This series is extremely easy to compute, and tables of ratios of x and y with arguments a and ϕ can be prepared from which any one projection of the series can be derived by merely applying a constant multiplier to the tabulations.

Table I gives the values of the ratio of y over the distance of the pole from the equator on the projection. Table II gives the values of secant $(a\phi)$ cosine ϕ. Figures for the sinusoidal, eumorphic, and Mollweide projections are also tabulated for comparison. To obtain the coordinates of a point on a required projection, multiply the ratios in Table I, using the appropriate a column, by

$$\frac{R}{Ka} \sin\left(\frac{a\pi}{2}\right).$$

This gives y. Similarly, in Table II multiply the figure given by $RK\lambda$. This gives x. In both cases R is the radius of the projected sphere. K may be

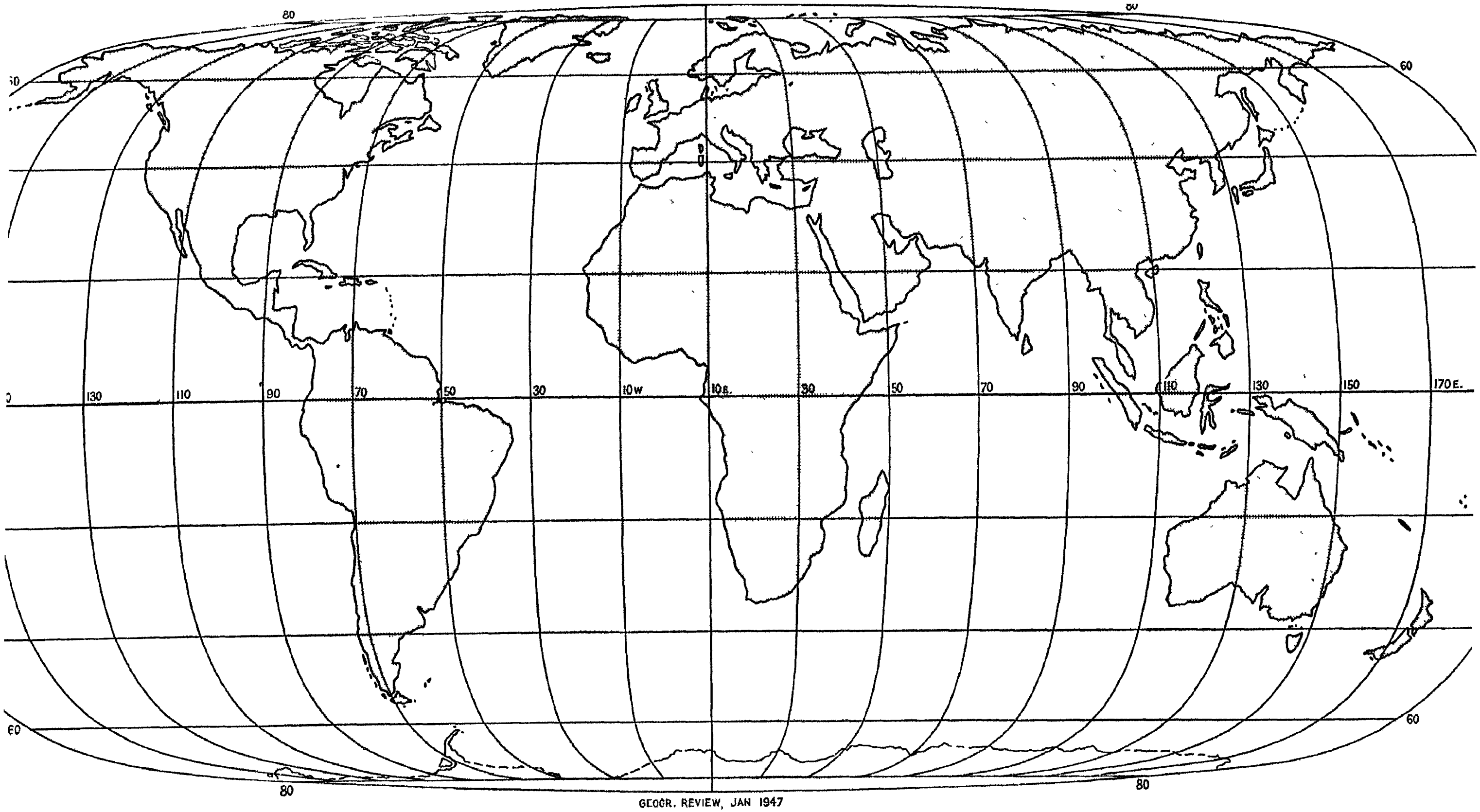


FIG. 3—A sketch map on an equal-area projection in the sine series with straight-line parallels. $a = 0.9$. Standard parallels at 30° N. and S.

arbitrarily chosen, but if it is made equal to cosine $(a\phi_s)$ then ϕ_s will be the standard parallel.

THE LIMITING CASES

It is of considerable interest to note that the functions

$$\frac{1}{a}\log_e \tan\left(\frac{\pi}{4}+\frac{a\phi}{2}\right),\quad \frac{1}{a}\tan(a\phi), \text{ and } \frac{1}{a}\sin(a\phi)$$

all tend to the value ϕ as a tends to zero. Thus Bonne's projection appears as the limiting case in equation (13); the azimuthal-equidistant as the limiting case in the azimuthal group; and the simple or equal-spaced cylindrical and the sinusoidal as the limiting cases of projections derived from (3), the former when $x=\lambda$ and the latter when x is modified in respect to y in order to produce the equal-area property.

Such is the flexibility of the general equation that it appears capable of embracing projections which, in their varied efficiency and elegance, can meet most cartographical requirements. Though the writer has not the time to continue this study, it is hoped that this paper will stimulate others to pursue the subject further, particularly in the evolution of some rational means of choosing the factor a in order to produce minimum distortion over the area to be mapped.

FOURTH GENERAL ASSEMBLY OF THE PAN AMERICAN INSTITUTE OF GEOGRAPHY AND HISTORY*

WITH NOTES ON A TRIP FROM CARACAS TO BOGOTÁ

CHARLES B. HITCHCOCK

THE Fourth General Assembly of the Pan American Institute of Geography and History was held in Caracas from August 22 to September 1, 1946. The participants were greatly indebted to the Venezuelan government and to its Organizing Committee, under the leadership of Dr. Cristóbal L. Mendoza, for the careful arrangement of conference sessions, exhibits, and social functions.

The formal opening of the General Assembly took place on Sunday afternoon, August 25, with the Revolutionary Junta present. Three days earlier the Institute's Commission on Cartography had begun a series of daily conferences that were to run conjointly with those of the General Assembly. All meetings were held at the Liceo Andrés Bello, a new school of modern design with auditorium facilities for plenary sessions and evening lectures. Ample quarters were also provided for section meetings and for the Secretariat and the representatives of the various nations. With the exception of Bolivia, the Dominican Republic, and Honduras, all the American republics sent official delegates. Canada, which is not a member of the Institute, and the United Nations also sent delegates, and in addition more than 30 government bureaus and scientific bodies, including the International Union of Geodesy and Geophysics, were represented.

The invitation of the Chilean government to hold the Fifth General Assembly in Santiago in 1950 was unanimously accepted. The following officers were elected to serve until that time: Dr. José Carlos de Macedo Soares of Brazil, President; Mr. Robert H. Randall of the United States, First Vice-President; General Eduardo Zubía of Uruguay, Second Vice-President.

CHANGES IN ORGANIZATION

In the opinion of the writer, the most important accomplishment of the Assembly was probably the reorganization of the Institute's bylaws and constitution to permit the creation of a series of commissions in the fields of geography and history. This opinion is based on the hope that these new

* Mr. Hitchcock represented the American Geographical Society at the General Assembly and also acted as a delegate for the United States to the Third Consultation on Cartography.—EDIT. NOTE.

commissions will function somewhat along the lines of the previously created Commission on Cartography. So far as the United States delegation as a whole was concerned, there was no discussion of the proposed reorganization, nor, at the time of writing, has the writer seen a copy of the bylaws finally adopted.

Up to the time of the Third General Assembly, at Lima in 1941,[1] meetings had been held at intervals of approximately three years. At that time a Commission on Cartography, which was to meet more frequently than the General Assembly, was created to develop mapping standards, exchange cartographical information and technical personnel, and maintain a close international relationship with respect to current national mapping needs and activities. This commission, financed for the first three years largely by the United States, held its First Consultation in Washington and New York in 1943 under the sponsorship of the American Geographical Society,[2] its Second Consultation in Rio de Janeiro in 1944 under the aegis of the Conselho Nacional de Geografia of Brazil.[3] The Third Consultation, as has been noted, was an integral part of the Institute's Fourth General Assembly.

One great advantage enjoyed by the Commission on Cartography has been the frequency of its meetings, which permits an efficient exchange of ideas and maintains a keener inter-American interest in the field of cartography. An important aspect of its organization has been the appointment of a secretary whose duty is, among other things, to travel in the various countries, collecting material and paving the way for future conferences.

The operations of the Commission on Cartography have proved so successful that the Caracas General Assembly accepted the offer (approved in April, 1946, by the Institute's Executive Committee in Mexico) of the Brazilian government, made through its Conselho Nacional de Geografia, to underwrite the organization of a Commission on Geography modeled along the same lines. The commission will have its temporary seat in Rio de Janeiro, and groups with common interests will meet at intervals between General Assemblies.

The Assembly also accepted the Mexican government's offer, made through the Sociedad Interamericana de Antropología y Geografía, to sponsor a Commission on History. Two special committees within the historical field were likewise approved: one, under the sponsorship of Vene-

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[1] C. B. Hitchcock: Third General Assembly of the Pan American Institute of Geography and History, *Geogr. Rev.*, Vol. 31, 1941, pp. 499–500.

[2] R. H. Randall: Consultation on Cartography, *Geogr. Rev.*, Vol. 34, 1944, pp. 129–131.

[3] "Consultation on Geography and Cartography," *Geogr. Rev.*, Vol. 35, 1945, pp. 154–155.

zuela, for the collection and publication of material on the "independence period"; the other, under the sponsorship of the Argentine Republic, for the collection of material relative to the history of the Americas.

The future operation of the Institute will thus be through commissions, meeting jointly at General Assemblies and separately at least once in the interim.[4] The Commission on Cartography will hold its next meeting in Buenos Aires in 1947, at the invitation of the Argentine government, and the other two commissions will probably meet before the next General Assembly.

The Assembly Program

The Assembly was divided into four section meetings, two in geography and two in history:

I. Topography, cartography, geodesy, and geomorphology.

II. Human geography, ethnography, historical geography, biogeography, and economic geography.

III. Pre-Columbian history and archeology, colonial history, library and archival research (particularly Spanish and Portuguese).

IV. History of emancipation, history since independence, organization of libraries, map collections, etc.

The work of only the first two sections will be considered here. Of these, Section I, the Commission on Cartography, was in a position to proceed with an orderly discussion of problems that had already been posed, whereas Section II, representing the new Commission on Geography, was at a disadvantage in that its proposed functions had not yet been outlined.

Section I: The Commission on Cartography

This commission discussed matters relating primarily to surveying, map standardization, and exchange of materials. Geomorphology, on which only a few papers were presented, was recommended, logically, for transfer to Section II, and the Committee on Cartography and Geography was replaced by a Committee on Special Maps to deal with geological, soil, vegetation, population, and other distribution maps of interest to the geographer.

In order to obtain information on the progress of surveys and maps since the 1944 conference, questionnaires had been distributed among the various countries before the Caracas meeting, and these resulted in a series of coordinated reports. Among them, the printed report of the Argentine

[4] For a more detailed statement of organizational changes see R. H. Randall: Fourth General Assembly of the Pan American Institute of Geography and History and Third Pan American Consultation on Cartography, *Bull. Pan Amer. Union*, Vol. 80, 1946, pp. 611–615.

Republic, with its elaborate series of index maps, deserves special mention.[5]

Uniform specifications for geodetic surveying and topographical mapping were adopted. The Greenwich meridian was recommended as the standard meridian of reference. Uniform specifications for aeronautical charts on the scale of 1 : 1,000,000 had already been adopted in 1944.

The need for a guide for aviators was recognized, and procedures were outlined for its publication. This guide, as proposed, will include current notes to aviators, a list of airports, radio aids to navigation, and maps and information on landing fields and facilities.

In the field of hydrography, special interest was shown in electronic developments. It was recommended that countries without hydrographic services should establish them as soon as possible. Paraguay reported that it already has a radio service for navigation on the Río Paraguay and is preparing to publish a bulletin, *Derrotero Río Paraguay*. Colombia indicated that a hydrographic service has been planned and will probably soon be started.

Section II: The Commission on Geography

In this section considerable time was devoted to discussion of the organization of the new commission and to presentation of resolutions. At the time of writing, no copy of the resolutions adopted in the final acts of the Assembly has been seen by the writer. Little time was given to the reading of papers, and those presented were largely in abstract form, without topical order, and were not discussed to any extent. However, with the commission under the active sponsorship of the Brazilian Conselho Nacional de Geografia it should be possible in the future to organize committees with common interests.

As regards the commission and its objectives, two opinions were advanced: (1) that it should be devoted mainly to the promotion of geographical research; (2) that equal or possibly greater weight should be given to the pedagogical aspects. Although fully realizing the importance of the teaching aspects, the writer feels that the chief function of this new commission, if it is to maintain an active international following among scientists, is the promotion of scholarly investigations. This in turn necessitates committees composed of individuals internationally recognized in the field of geography. A mimeographed statement of the proposed organization and functions of the commission was distributed and, with some modifica-

[5] "Memoria sobre los trabajos ejecutados en el período agosto 1^{e} de 1944–junio 30 de 1946, presentados a la III Reunión Panamericana de Consulta sobre Cartografía," República Argentina, Buenos Aires, 1946.

tions, was accepted; a list of eight tentative projects was, however, deleted in its entirety, the feeling being that it was still too soon to accept specific recommendations.

As provisionally organized, the commission will carry on its work through five permanent committees: physical geography, biogeography, human geography, regional geography, and the teaching of geography. Other committees may be set up later, or the above five may be modified, as seems desirable. The development of the Commission on Geography will be awaited with interest.

Cartographical Exhibition

The cartographical exhibition at the Pavilion of the National Hippodrome was an outstanding feature of the Assembly. The time and labor obviously given to planning and arrangement had been well expended, and the members of the Organizing Committee who took part in the preparation are to be congratulated. By no means all of the American republics participated. Of the Central American republics, only Guatemala displayed maps; none of the Caribbean island republics were represented, nor were Bolivia, Chile, Paraguay, and Uruguay. Partitions had been erected to permit individual display of national exhibits, and all maps had been neatly set off in frames without the overcrowding that is often a defect of map exhibits. In addition, tables were supplied for the display of a wide variety of geographical books, periodicals, manuals, and guides.

The entrance room was devoted mainly to large diagrams showing the status of Venezuelan geodetic work and to Boundary Commission photographs, and through the far door one could see on the facing wall of the next room a photomosaic of the Araya and Paria Peninsulas and the Isla de Margarita (1 : 28,800), effectively displayed against a black background. Large-scale photomosaics of some seven Venezuelan cities completed this room. Venezuelan interest in urbanization is keen. Caracas, for example, is in the midst of a great building boom, which was going on even during the war. Hotels, office buildings, and apartment houses are being erected. Laborers are migrating from the rural areas to work on construction projects, thus adding to the housing difficulties. Traffic problems are increasing, and water supplies must be augmented. An extensive slum-clearance program has been completed in a section known as El Silencio (Fig. 1). Building activities are also going on in the oil centers, and a new city is being planned. Incidentally, the writer found a similar building boom in Bogotá when he visited that city shortly after the close of the meetings in Caracas. There is

full realization in Venezuela of the need for detailed city plans, and photogrammetry is the answer. Several other national exhibits bore witness to the same keen interest in photogrammetry. Indeed, this Venezuelan exhibit might almost be said to keynote the exhibition as a whole.

In following rooms there was a wide selection of Venezuelan maps, ranging from a chronological series of historical maps[6] to recently con-

FIG. 1—New housing development in the El Silencio section of Caracas.

structed but largely unpublished sheets prepared by the Dirección de Cartografía Nacional. Excellent progress is being made on the new topographic series on the scale of 1 : 25,000. The sheets of this series, constructed with stereoplanigraph and multiplex, have a 20-meter contour interval. A composite unit covering the coastal Andes in the Caracas region from Laguna Tacarigua to a point some kilometers west of the capital and another large unit centering around San Cristóbal, state of Táchira, were impressive demonstrations of present activities. A number of examples of the new series on the scale of 1 : 100,000 and three sheets of the 1 : 250,000 series, both without contours, were also exhibited. Among nongovernmental mapping projects, a compilation of exploratory river traverses in the Guayana by Captain Felix Cardona and three elaborately printed topographic sheets by the Shell Oil Company were outstanding. A preliminary manuscript copy of a geologic-tectonic map of Venezuela by Professor Walter Bucher was also of interest.

In the Argentine exhibit, five new sheets of the Carta Aeronáutica de la República Argentina, 1 : 1,000,000, published in 1945–1946 by the Instituto Geográfico Militar and printed with green and buff hypsometric tints,

[6] Through the Organizing Committee, a specially prepared atlas, "Cartografía histórica de Venezuela, 1635–1946," was distributed to the delegates.

marked a new development in Argentine map making. Examples of various standard series and progress charts by the Instituto, the Ministerio de Marina, and the Ministerio de Agricultura completed the display.

Brazil was represented by several government agencies. Particularly noteworthy were examples of topographic maps prepared by the Brazilian Army, mainly by photogrammetric methods. These maps ranged in scale from 1:20,000 to 1:50,000 and, with one exception, were printed in black. The exhibit of the Conselho Nacional de Geografia included a recently completed hypsometric map of the country (1 : 5,750,000) and two unpublished sheets in the Amazon Basin (1 : 500,000) compiled from trimetrogon photography. The mapping work of the Diretória de Hidrografia e Navigação was also well represented.

Colombia's exhibit included a number of relatively new *municipio* maps prepared by the Instituto Geográfico Militar by photogrammetric methods and a photostatic copy of an unpublished air survey of the city of Medellín on the scale of 1:5000. Unfortunately, no sheets of the new Carta Preliminar, 1:25,000, which will eventually be incorporated in the general map of Colombia on the scale of 1:100,000, were shown. This new series marks a distinct advance in the Colombian mapping program. Instead of being restricted to political boundaries, each sheet is limited by a grid system. These sheets, 40 by 60 centimeters in size, are printed in four colors and usually have 100-meter contours. Through September, 1946, 20 sheets, mainly in Cundinamarca, had been prepared by photogrammetric methods.

Ecuador's principal exhibit consisted of sheets of the Mapa Topográfico del Ecuador, 1:25,000 and 1:20,000, printed in three colors, with a 25-meter and 20-meter contour interval respectively. Peru's chief contribution was made up of more than 70 sheets of the Carta Nacional, 1:200,000, prepared by the Servicio Geográfico del Ejército. Guatemala presented a new 12-sheet planimetric map of the country and Belize on the scale of 1 : 200,000. Mexico's exhibit, in addition to examples of its older and better-known series, included several sheets in black and white, 1: 50,000, prepared in part by photogrammetrical methods; vertical mosaics of several cities; a large map of the state of Morelos, 1 : 50,000, published in 1943 by the Dirección de Geografía, Meteorología, e Hidrografía; and photostatic copies of the Mapa Preliminar, Zona de Michoacán, 1: 500,000, contour interval 200 meters, prepared by the photogrammetry section of the Dirección.

Exhibits from the United States included a good sampling of maps by the major government mapping agencies, examples of surveying instruments currently in use, and some captured German and Japanese maps.

The American Geographical Society exhibited the sheets of its Map of Hispanic America, 1 : 1,000,000, covering Venezuela, other selected sheets of this series, and recent maps from the *Geographical Review*. The Geological Society of America sent copies of its geological maps of North and South America and a copy of its Glacial Map of North America.

Other Features of the Meetings

At the offices of the Dirección de Cartografía Nacional the delegates were given the opportunity to inspect its modern photogrammetrical and other surveying equipment and to examine maps in various stages of preparation. A special exhibition of historical and geographical books had been arranged at the National Library[7] and an exposition of Venezuelan archeology at the Science Museum. Delegates also visited the collection of Venezuelan birds assembled by Mr. William H. Phelps, which is extraordinary for the examples of endemism from the sandstone mountains of tropical Guayana.

THE PAN-AMERICAN HIGHWAY, CARACAS TO BOGOTÁ[8]

On the day before the formal closing of the Assembly the writer departed by bus for Bogotá. With no breakdowns or road blocks, it is possible to reach the Colombian city of Cúcuta in four days and Bogotá in two days more—a total distance of about 1780 kilometers (1106 miles). In contrast, less than 6 hours' flying time is required to reach Bogotá from Caracas by way of Barranquilla. The bus fare to San Cristóbal, near the Venezuelan border, was 32 bolivars ($10.56 United States currency), and the fare for the shorter part of the trip in Colombia was proportionate. Food served at roadside stops (Fig. 3) was abundant and relatively cheap, averaging from 50 to 65 cents a meal. Overnight lodgings also averaged about 65 cents.

Condition of the Road

The route follows the cement highway to Valencia and Puerto Cabello as far as the small lowland settlement of Taborda (Fig. 2). From Taborda gravel-surfaced road extends to the boundary. Except for a short macadam-

[7] "Catálogo de la exposición de libros de geografía e historia de Venezuela," Cuarta Asamblea del Instituto Panamericano de Geografía e Historia, Caracas, August, 1946.

[8] The following notes on current conditions and impressions along the route are added for the benefit of anyone who may contemplate making this trip. A more detailed account of the journey is on file at the Society. Also, a somewhat similar report can be found in R. E. Crist: The Caracas-Quito Highway, Part I, The Venezuelan Section, *Bull. Pan. Amer. Union,* Vol. 76, 1942, pp. 601–609; Part II, The Colombian and Ecuadorean Sections, *ibid.*, Vol. 77, 1943, pp. 4–12.

ized stretch between the boundary and Cúcuta, the Colombian section of the highway is also gravel-surfaced as far as Duitama, from which point the writer traveled in a Diesel-powered, single-car train to Bogotá. From Barquisimeto westward across the desert of Lara to a point within a few kilometers of Carora the road has recently been widened and regraded, and modern culverts and steel bridges have been constructed, so that excellent all-weather travel is now possible along a section reported only a short time ago to be in bad condition. In the mountains of western Venezuela it is impossible to predict when and where an avalanche or sudden freshet will temporarily obstruct traffic in the wet season, but, in spite of this, bus and truck service is regularly maintained throughout the year. In many places the highway has of necessity been cut in unconsolidated alluvial fill, and not only slumping of the mountainsides but valleyward sapping of the road itself may cause extensive damage. Similar conditions exist along the Colombian section. One short stretch particularly liable to obstruction in the wet season lies along the Río Chama between Puente Nacional and Estanques, a rain-shadow section of the valley with only a sparse cover of xerophytic vegetation to hold back the debris brought down by sudden rains. True to its reputation, this stretch provided the worst of several obstructions encountered; traffic had been held up for 18 hours before our bus finally got through the debris block on the road (Fig. 4). Near Valera, where short delays were caused first by an avalanche, then by a freshet, and finally by a fallen tree, all within a distance of two kilometers, an amusing incident took place, which was interpreted as evidence of the relatively common occurrence of such wet-season travel hazards. We first saw a man driving two large black pigs late in the afternoon at the avalanche, which he proceeded to cross without any sign of interest in the difficulties of mechanized travel. Beyond the avalanche we passed him, only to have him catch up with us at the freshet, nonchalantly driving his pigs through the rushing water in the dark. Again we passed him, and again at the fallen tree he scrambled across the debris of limbs while we waited for the road to be cleared. Somewhat later, just before reaching Valera, we saw him for the last time, still ambling along unconcernedly with his two black pigs.

The Landscape

Two aspects of the Caracas-Bogotá journey are particularly striking: the rapid passage altitudinally from tropical to subtropical, subtropical to temperate, and temperate to paramo conditions; and the abrupt changes in precipitation experienced within the temperature zones. The adaptation of

people and agriculture to these changing conditions presents a truly remarkable picture.

As one travels westward from Caracas in early September, a predominantly fern-covered upland characteristic of the upper subtropical and temperate coastal Andes is first traversed, but the road soon descends through a countryside of scattered coffee plantations into the fertile Valencia Basin, with its broad expanses of sugar cane, cotton in bloom, rice, citrus groves, and pastures. Then, almost before one realizes it, there has been another change: the green expanses have been replaced by the xerophytic vegetation of the hot tropical coastal lowlands. For a few minutes the Caribbean is visible. Extensive plantings of coconut palms give way to broad grazing lands cleared from tropical forest. The settlements are small and largely negro. In September, 1946, each house bore a large painted notation that it had been sprayed with DDT in the recent campaign to ameliorate locally bad malarial conditions.

For some little distance before the road crosses the Río Yaracuy it passes through a fine tropical rain forest with a wide variety of enormous trees and vines, reminiscent of southern Venezuela and the Amazon Basin. Locally, logging is carried on, and where the forest has been partly cleared there are large plantings of bananas. Toward the end of the first day, as the road begins to rise southwestward, there is a rapid transition from lush vegetation to cactus and thornbush; near Barquisimeto (566 meters) the principal crop appears to be *cocuy*, the local agave which is the source both of a potent liquor and of a fiber.

For the first half of the second day the route crosses the hot tropical desert of Lara, a predominantly mountainous country with bedrock outcropping everywhere and eroded slopes covered with cactus and other xerophytic plants (Fig. 5). In September the *yurimaco*, a low tree growing in the valley depressions, is covered with yellow bloom. The few settlements are far apart; occasionally there is a rude, mud-plastered hut (Fig. 7) with a few pigs, chickens, and goats. A short distance south of Carora, where the road approaches the northern terminus of the western Venezuelan Andes, there is a remarkable transition from desert to moderately humid tropics (Fig. 8). Carora, dominated by a modern water-storage tank, lies on parched land; Sicarigua, only 33 kilometers (20 miles) to the south, is a sugar central. Before reaching Valera (654 meters), the center of a thriving pineapple industry, the road crosses a broad and grassy plain, the Sabana de Monay, on which many cattle graze. One of the more striking features of the Andean landscape, physiographically, is the series of great alluvial terraces that become prominent in this region.

FIG. 2—Section of the American Geographical Society's Map of the Americas, 1 : 5,000,000, showing the American Highway between Caracas and Bogotá. Reproduced in half tone from the original in color. Linear s approximately 80 miles to the inch.


FIG. 3—Roadside eating place, Taborda.


FIG. 4—Debris-blocked road near Puente Nacional.


FIG. 5—View in the Lara desert, between Barquisimeto and Carora.

FIG. 6—Village of Los Yavos, in the Lara desert.

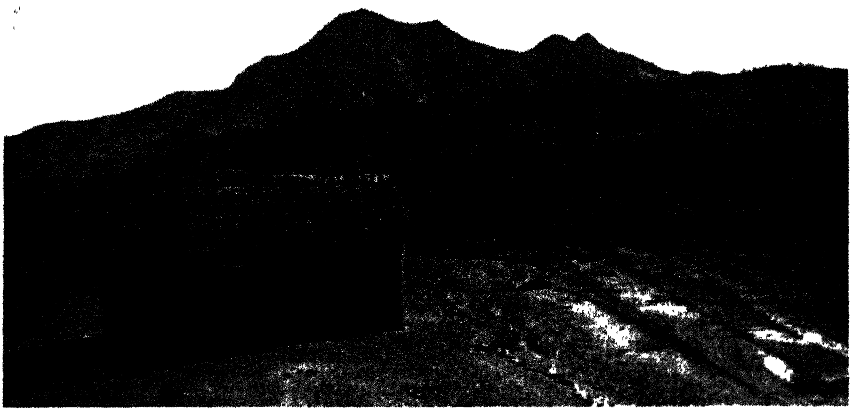

FIG. 7—Mud-plastered hut near Los Yavos.

FIG. 8—View on the highway just south of Sicarigua.

Fig. 9—The highway at Puente Villegas.

Fig. 10—The Río Chama at Puente Nacional, looking upstream.

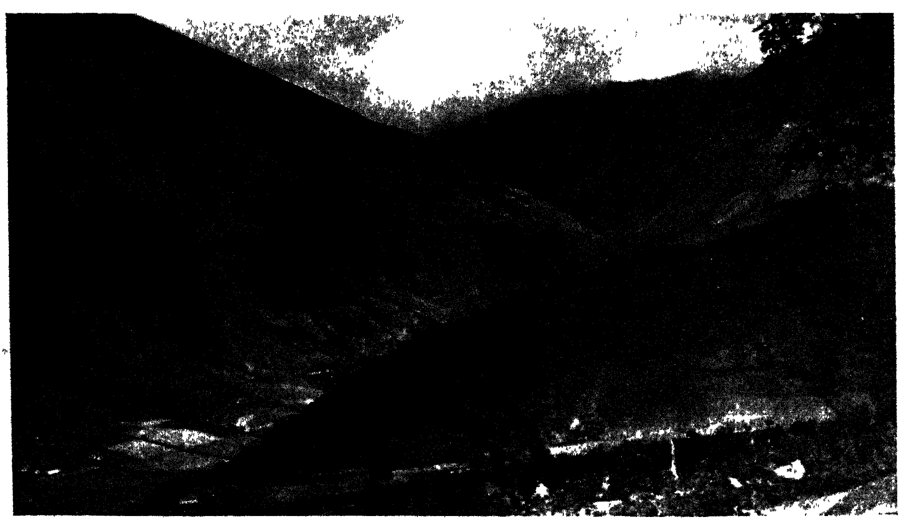

Fig. 11—Cultivated slopes above Bailadores.

FIG. 12—The Chicamocha Valley near Soatá, looking south.

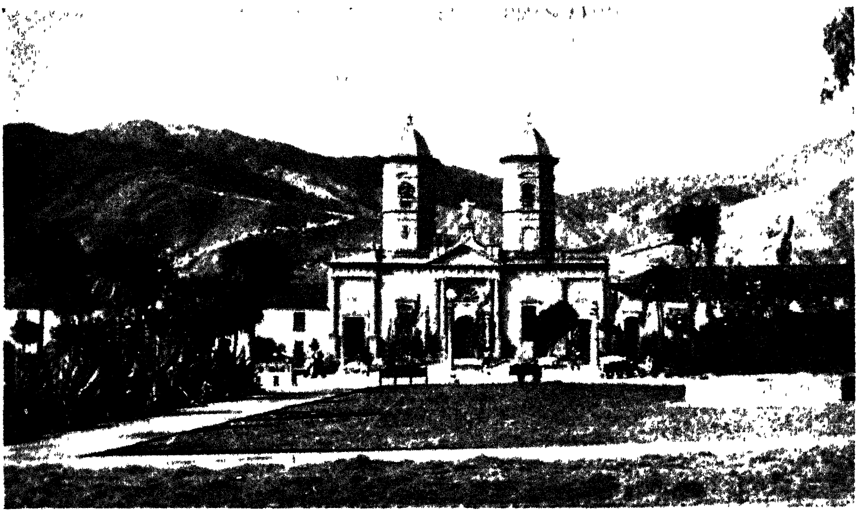

FIG. 13—Church and plaza at Pamplona.

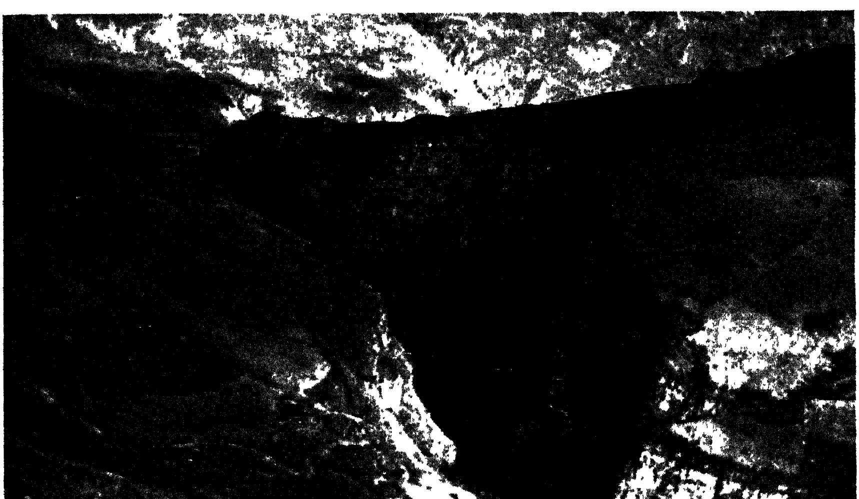

FIG. 14—Looking down from the highway, near Soatá. Fields extend to the cliff edge.

The third day the road rises into the temperate belt between 2000 and 3000 meters, with its fields of wheat and potatoes, and then into the paramos, the true *tierra fría* above the tree line. In these higher regions the people are of ruddier complexion, and serapes are worn—not in the bright colors common in upland Peru but somber browns and blacks. The smallest town has its plaza planted with such flowers as white calla lilies, marigolds, pinks, and gladiolas—a contrast with the palm-decorated plazas of the humid lowlands and the little square patch of desert in Carora. Signs of glaciation now begin to appear—little side-valley cirques and loop moraines cut by small streams that are building out large fans, many of them perfect textbook illustrations. Everywhere on these fans we saw wheat stubble, and between them the mountain slopes were barren. The narrow valley bottom was given over largely to potatoes and wheat. Near the scattered houses were low, stone-ringed threshing enclosures. In this stony land the cultivated fields are commonly set off by low stone walls. The paramo was a garden of alpine flowers in many shades of blue, purple, lilac, red, and yellow, dominated by the characteristic Andean *frailejón,* a giant dandelion with silvery velvet leaves and clusters of upright yellow flowers. At the high pass across the Páramo Mucuchíes (4118 meters), which was crossed after dark, a cold rain was falling. The bus passengers were none too warm, and several were affected by the altitude.

The following day we passed into a cactus and thornbush rain-shadow area in the Chama Valley, only to return suddenly to subtropical luxuriance where the Chama River turns northwest through a broad break in the Andean front to the Maracaibo lowlands, permitting moist winds to penetrate to the interior. The rest of the trip is a succession of such rapid changes. The Páramo Almorzadero in Colombia is the somewhat lower counterpart of Mucuchíes. The Chicamocha Valley, in particular, is impressive for its scenic views, its exposures of folded sedimentaries, and its great dissected alluvial terraces (Fig. 12). A geologist who has spent many years traversing the valleys of the Chilean Andes on muleback commented, after crossing them recently by plane: "The airplane isn't fair to the Andes." In this case, the Andes seem only reasonably fair to the highway.

ITALIAN BOUNDARY PROBLEMS: A REVIEW

GEORGE KISS

IN THE stormy history of the Paris Peace Conference of 1919 more than one severe crisis was caused by the boundary problems of Italy. Reports from the conferences of foreign ministers at London, Moscow, and Paris in 1945 and 1946 and from the Paris Peace Conference of 1946 indicate that Italy's boundaries with France, Austria, and Yugoslavia are again among the principal stumbling blocks on the road to peace. Seldom in the long history of frontier disputes have a nation's boundaries been discussed in as much detail as those of Italy, and seldom have so many divergent opinions been expressed. Some of the recent literature on the subject is here reviewed, as a background for discussion of the new boundaries proposed in the draft of the peace treaty with Italy, released in the summer of 1946.[1]

Conflicting Census Data

It must be pointed out first of all that among the difficulties encountered by any student of Italian boundaries conflicting census data are perhaps the most serious. We may take as an example the Julian region. Estimates of the present Italian population range from 250,000 to 400,000, estimates of the South Slav population from 600,000 to 650,000.[2] According to the Austrian census of 1910 there were in the region at that time 366,385 Italians and 471,008 South Slavs.[3] In view of the displacements of population after World War I and the forced migrations and deportations between 1923 and 1946, the 1910 census figures seem hardly valid at the present time. However, because neither Italy nor Yugoslavia seems willing to accept the other's census data, the 1910 figures are still considered the best available indices of the distribution of nationalities in the Julian region.

The South Tirol offers another example of the discrepancies between ethnic statistics from different sources. Gaetano Salvemini,[4] writing on Italian frontiers, states that 179,083 German-speaking residents of the South Tirol chose to migrate to Germany in 1939 and that only 89,000 remained. An English source,[5] on the other hand, says that 185,085 German-speaking residents voted on December 31, 1939, for repatriation to the Reich, and estimates of the number of those actually repatriated range from 75,000 to 100,000. It is clear, then, that determination of the validity of population statistics presents a delicate problem in the settlement of international boundaries.

Italian-French Boundary

Boundary adjustments between Italy and France are discussed by Cyril Falls in "The Franco-Italian Boundary."[6] Captain Falls points out that the changes in the boundary are

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[1] *The New York Times*, July 27, 1946.

[2] According to sources cited in C. Grove Haines: Trieste—A Storm Center of Europe, *Foreign Policy Repts.*, Vol. 22, 1946, pp. 14–23; reference on p. 15.

[3] Figures as derived from M. K. G.: The Venezia Giulia Question, *The World Today*, Vol. 1 (N.S.), 1945, pp. 147–159; reference on p. 151.

[4] Gaetano Salvemini: The Frontiers of Italy, *Foreign Affairs*, Vol. 23, 1944–1945, pp. 57–65; reference on p. 65.

[5] M. K. G.: The South Tirol and Its Future, *The World Today*, Vol. 1 (N.S.), 1945, pp. 270–280; reference on pp. 276–277.

[6] Cyril Falls: The Franco-Italian Boundary, *The Illustrated London News*, July 6, 1946, p. 12.

minor and that in every case considerations of frontier defense and of easy communication between France and the areas to be ceded by Italy have determined French demands. It should also be noted that the draft peace treaty provides guarantees safeguarding Italian interests in hydroelectric power generated in plants formerly on Italian soil and use by Italy of water from rivers originating in territory ceded to France but flowing toward Italy.[7]

Italian-Austrian Boundary

The problem of the Italian-Austrian boundary is the subject of several recent articles. Professor Salvemini, in "The Frontiers of Italy,"[8] is concerned mainly with establishment of political guarantees ensuring equal rights to national minorities on both sides of the frontier. He does not suggest a new boundary in the South Tirol, and one might infer that the Austrian-Italian boundary of 1919, which follows the Alpine crest line, is entirely satisfactory from the Italian point of view.

In "The Southern Boundaries of Austria" Erik R. v. Kuehnelt-Leddihn[9] emphasizes the difficulties of boundary making in a region of complex ethnic character. He proposes that the Central Tirol, the area north of the Salorno (Salurn) Pass, be returned to Austria and that a plebiscite be held in the Trentino to determine the fate of that area. His arguments in favor of Austrian control of at least the Central Tirol are both economic and ethnic. This part of the Tirol (the Alto Adige region of the Italians) produces surpluses of hydroelectric power, fruit, and wine, which would find ready markets in the Alpine provinces of Austria. Ethnically, Dr. Kuehnelt-Leddihn points out, the people of the Central Tirol are predominantly German, both in speech and in sympathy, and to detach them from their German-speaking brethren north of the Brenner Pass would be to run counter to the principles laid down in the Atlantic Charter.

"The South Tirol and Its Future"[10] is an impartial and detailed review of the diverse aspects of the South Tirol problem. After recalling the settlement of 1919 and pointing out that President Wilson himself admitted that "his promise of the Brenner frontier to the Italians was 'a grave mistake,'" the writer emphasizes that both sides were guilty of serious errors and excesses between 1919 and 1945. The strong, sometimes ruthless, attempts of the Italian government to Italianize the entire Tirol south of the Brenner Pass were followed, after 1943, by a period of German rule. After the Italian armistice of that year Germany incorporated the Italian provinces of Bolzano, Belluno, and Trento in the province of Tirol-Vorarlberg. The short period of German occupation, lasting until the German armistice in the spring of 1945, only further embittered relations between the German-speaking and Italian-speaking groups of the South and Central Tirol. The attempted evacuation to the Reich, in 1939, of all German-speaking inhabitants of the Tirol south of the Brenner Pass was an only partly successful solution of the problem of the Tirol. A solution acceptable to both sides would have to assure full civic rights to national minorities, both Austrian and Italian. Only thus could the boundary endure.

The omission from the draft treaty of any reference to the Austrian-Italian boundary

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[7] Annex 2 of the draft treaty.

[8] *Op. cit.*

[9] Erik R. v. Kuehnelt-Leddihn: The Southern Boundaries of Austria, *Journ. of Central European Affairs*, Vol. 5, 1945–1946, pp. 243–259.

[10] M. K. G., The South Tirol and Its Future (*op. cit.*); reference on p. 272.

(i.e. the restitution of the 1919 boundary) indicates that the treaty-making powers chose to disregard the problem of the German-speaking population south of the Brenner Pass. The principal objections voiced by Italy to any change in the northern boundary emphasize the defensive value of the Alpine crest line and the importance of electric energy generated in Italian-built plants in the Central Tirol. As regards the first objection, most writers seem to agree that in modern three-dimensional warfare the value of mountains as "natural" frontiers is somewhat limited. The insistence on retention of the Central Tirol because of the Italian hydroelectric plants in the region seems weakened by the Italian government's willingness to accept the guarantees in the draft treaty regarding Italian hydroelectric plants in territory transferred to French sovereignty.

In connection with the Italian demand for the Alpine crest line as the "natural" boundary of northern Italy, certain relationships pointed out by Albrecht Penck[11] during the negotiations that preceded Italy's entry into World War I may throw some interesting light on current disputes. In 1914, barely three-sevenths of the total length of the Alpine crest line was used as an international boundary, and the divide between the drainage basins of streams flowing to the Adriatic and those of the Rhone, the Rhine, and the Danube was followed by international boundaries for less than half of its length. Since 1914 the "natural" boundaries of the region have continued to be relatively unimportant. Fighting in Italy during both World Wars was far to the south of the Alpine crests, and the political boundaries established in 1919–1924 along the main crest line of the Alps and the Adriatic-Danube divide were not durable.

Italian-Yugoslav Boundary

Of all the boundary problems of Italy that of the Italian-Yugoslav frontier seems to be the most difficult to settle, though few regions of Europe have received such detailed study, beginning with the investigations of the American experts at the Paris Peace Conference of 1919.

In "The Italo-Jugoslav Frontier" Professor Salvemini,[12] as in his earlier paper, urges the importance of a just regime for national minorities on both sides of the boundary. He suggests that the Austrian census of 1910 and the recommendations made by the American experts in 1919 be accepted as a basis for the peace negotiations. Thus from an Italian point of view the boundary proposed by the Americans in 1919, better known as the Wilson Line, would come closest to being a just settlement of the Italo-Yugoslav boundary dispute. However, the recommendations made by the draft treaty leave little doubt that such a solution of the problem will not be discussed.

René Albrecht-Carrié, in "The Northeastern Frontier of Italy,"[13] seems to agree with Professor Salvemini's proposals and observes that, "taking all the circumstances into account, the American or Wilson line of 1919 constitutes probably the best compromise." Professor Albrecht-Carrié suggests, in view of the existing relationship between the powers interested in the Italo-Yugoslav dispute, that the present line of demarcation between Anglo-American

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[11] Albrecht Penck: Die österreichische Alpengrenze, *Zeitschr. Gesell. für Erdkunde zu Berlin*, 1915, pp. 329–368 and 417–448; reference on p. 335.

[12] Gaetano Salvemini: The Italo-Jugoslav Frontier, *Foreign Affairs*, Vol. 24, 1945–1946, pp. 341–346.

[13] René Albrecht-Carrié: The Northeastern Frontier of Italy, *Journ. of Central European Affairs*, Vol. 5, 1945–1946, pp. 229–242; references on pp. 239 and 241.

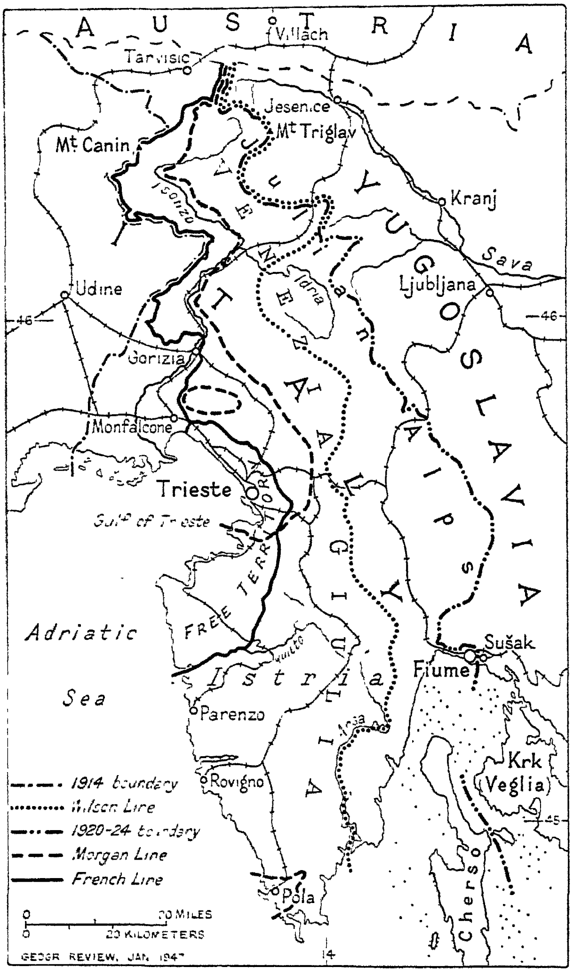

FIG. 1—The Italo-Yugoslav frontier. (The sources for the Wilson, Morgan, and French Lines were maps issued in 1946 by the U.S. Department of State.)

and Yugoslav zones of occupation in the Julian region, known as the Morgan Line, which in his opinion is ethnically more accurate than the Wilson Line, may become the permanent boundary. According to the draft treaty, the proposed boundary (known as the French Line) between Italy and Yugoslavia and between the Free Territory of Trieste and Yugoslavia will run roughly parallel to, and five to seven miles west of, the Morgan Line for most of its course. This leaves the important rail junction of Tarvisio in Italy but shifts the boundary west of the Isonzo, thus depriving Italy of the strategic advantage of controlling both banks of that river. In contrast, each of the settlements made from 1919 to 1924, as Dr. A. E. Moodie points out in "The Italo-Yugoslav Boundary: A Study in Political Geography,"[14] gave the strategic advantage of the boundary to Italy. There seems to be more than a little truth in Penck's remark that Italy's northern boundary, after swinging back and forth many times, has finally, like a pendulum, come to a standstill.[15]

Dr. Moodie's monograph is one of the most valuable contributions made to political geography in recent years. It presents a detailed survey of historical developments in the Julian region up to World War I and of boundary revisions there since 1918, projected against the geographical background. From several points of view the Julian region is of crucial importance. It is the meeting place of Mediterranean, German, and Slavic peoples. It has long been "an area of convergence of contending and expanding political powers":[16]

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[14] A. E. Moodie: The Italo-Yugoslav Boundary: A Study in Political Geography. viii and 241 pp. George Philip & Son, London, 1945. 8s. 6d

[15] *Op. cit.*, p. 444.

[16] Moodie, *op. cit.*, p. 56.

from the fourteenth century to the eighteenth, for example, Venice, Austria, and Turkey struggled for its control. But the region is not merely one of contact and of conflict. It is also the most important breach in the mountain wall of the northern Mediterranean rim between the Rhone-Saône corridor and the Vardar-Morava trench and offers one of the easiest passageways from the Mediterranean to the heart of Europe. The ports of Trieste and Fiume attest to its importance as a trade route. In view of attempts to revive these ports by assigning Fiume to Yugoslavia and making Trieste the capital of a Free Territory, it might be well to recall the experience of the 1920's and 1930's. The traffic of Trieste, one of Europe's great ports before World War I, fell from 6.12 million metric tons (sea and rail traffic together) in 1913 to 3.39 million in 1938; Fiume's traffic shrank from 4.04 million metric tons in 1913 to 0.77 million in 1938.[17] These figures reveal the plight of the two ports, cut off from their hinterland by customs barriers, unintegrated with Italian economic life, and dying slowly by economic strangulation. The planners of peace should heed the warning contained in these statistics.

Dr. Kuehnelt-Leddihn[18] makes an interesting proposal concerning the future of communications between Trieste and its hinterland. He suggests an Austrian corridor that would separate Italian from Yugoslav territory and give Austria and the other Danubian countries free access to the Adriatic. Although there seems to be small likelihood that such an arrangement would be acceptable to either party involved in the Trieste dispute, this proposal brings to public attention the importance of assuring easy communications between Trieste and the Danube Valley, either by way of the Southern Railway route (Vienna-Maribor-Ljubljana-Trieste) or by way of the Tauern Railway route (Salzburg-Villach-Jesenice-Gorizia-Trieste).

It is rather discouraging that the draft treaty does not acknowledge the problem of Trieste's economic relations beyond suggesting provisions to facilitate local trade between the Free Territory and neighboring parts of Italy and Yugoslavia.[19] Trade with the Danubian countries is vital to the survival of Trieste and Fiume. Dr. Moodie presents eloquently the need of these two ports for free communications and makes it clear that neglect of this aspect of postwar settlements may seriously endanger the chances of a permanent and peaceful solution in the Julian region.

At the time this review was written the Council of Foreign Ministers had not yet discussed the new Italo-Yugoslav boundary and the boundaries of the Free Territory of Trieste. In view of the debate that is certain to accompany this phase of the peace negotiations, one is bound to agree with Dr. Moodie's conclusion that "a linear boundary will be drawn somewhere . . ., but few will envy the statesmen who will be confronted with the task of its delimitation."[20]

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[17] *Ibid.*, p. 216.

[18] *Op. cit.*

[19] Annex 9, section D, of the draft treaty.

[20] *Op. cit.*, p. 230.

AMERICAN GEOGRAPHICAL SOCIETY

The November Meeting

The regular monthly meeting of the American Geographical Society was held on November 19, 1946, at the auditorium of the Engineering Societies Building, 29 West 39th Street, Dr. John K. Wright, Director of the Society, in the chair. Colonel Gerald FitzGerald, of the United States Geological Survey, delivered a lecture entitled "Aerial Photography's Contribution to Geographical Knowledge." Colonel FitzGerald, who during the war was commanding officer of the Army Air Forces' Aeronautical Chart Service, described how this agency accomplished the enormous task of photographing more than 15,000,000 square miles for the preparation of military maps and charts. The lecture was illustrated with lantern slides.

Aids to Geographical Research

In 1923 the American Geographical Society published as its *Research Series No. 10* "Aids to Geographical Research: Bibliographies and Periodicals," by John Kirtland Wright, at that time Librarian of the Society. A completely revised edition by Dr. Wright, now Director, and the late Elizabeth T. Platt, Librarian of the Society from 1937 until her death in 1943, is scheduled for publication this spring by the Columbia University Press as Number 22 of the Society's *Research Series.* Designed particularly to serve advanced students and professional workers in geography, it will deal not only with bibliographies and periodicals but also with a selection of atlases, gazetteers, and other reference books of geographical value and will contain, in addition, a classified check list of American professional geographers, libraries containing collections of geographical material, and institutions where geographical research is in progress.

Ronne's Proposed Antarctic Expedition

An expedition under the leadership of Commander Finn Ronne, U.S.N.R., expects to sail for the Antarctic from Beaumont, Tex., on January 10, 1947. It has been organized by the American Antarctic Association, a corporation established primarily for this immediate purpose. A small ship acquired from the United States Navy will be used and will carry a complement of 21 men. The equipment, largely furnished by the Army Air Forces, includes three planes and several dogs, the latter to be used in connection with the establishment of ground-control points for aerial surveys (trimetrogon). Besides surveying and mapping, the scientific program, which is being undertaken under a contract with the Office of Naval Research, includes studies of geology, meteorology, gravity, tides, solar radiation, cosmic rays, and the physiological responses of the human body to the Antarctic environment. Commander Ronne served with distinction on the Second Byrd Antarctic Expedition in 1933–1935 and on the United States Antarctic Service Expedition in 1939–1941. The Ronne expedition is under the auspices of the American Geographical Society, which expects to publish the geographical results in whole or in part.

Distribution of Title Page, Contents, and Index of Volume 36 of the "Geographical Review"

The title page, table of contents, and index for Volume 36 of the *Geographical Review* (1946), issued separately, will shortly be ready for distribution. Copies are sent to all institutions exchanging publications with the Society and to individuals who request that their names be put on a list for this purpose.

Our January Contributors

PROFESSOR SAUER, medalist of the American Geographical Society and contributing editor of the *Geographical Review*, hardly needs an introduction to our readers. His present article is a reflection of what he has described as "my favorite pursuits of trailing early man and learning something about plant domestication," as was his earlier "A Geographic Sketch of Early Man in America" (*Geogr. Rev.*, Oct., 1944). DR. SHARP's article on the Wolf Creek glaciers is a result of field work undertaken on the Wood Yukon Expedition of 1941, sponsored by the American Geographical Society. His service with the Arctic, Desert, and Tropic Information Center of the Army Air Forces during the war has delayed publication of the material until this time. Dr. Sharp is now associate professor of geology at the University of Minnesota.

MR. HANSON is a geographer and writer who began his professional life as an engineer. He has done considerable work on regional planning, first with the National Resources Committee, later in Puerto Rico, and recently in Liberia. His geographical studies have also taken him to Chile, Iceland, and the Amazon Basin (*Geogr. Rev.*, July, 1926; Jan., 1928; Oct., 1933). Mr. Hanson was editor in chief of the "Index to Map of Hispanic America, 1 : 1,000,000" (*Amer. Geogr. Soc. Map of Hispanic America Publ. No. 5*) and of the "New World Guides to the Latin American Republics," of which he is now preparing a third revised edition.

MR. HANSON-LOWE is a petroleum geologist associated with Anglo-Egyptian Oilfields Ltd. in Cairo. He is the author of "Notes on the Climate of the South Chinese–Tibetan Borderland," which appeared in the *Geographical Review* for July, 1941. MR. LU, formerly associate professor of meteorology at the National Che-Kiang University, has recently taken up his duties as chief meteorologist of the Central Weather Bureau in Nanking.

DR. STANISLAWSKI follows his earlier study of "The Origin and Spread of the Grid-Pattern Town" (*Geogr. Rev.*, Jan., 1946) with an investigation of the knowledge and use of the grid pattern in early Spanish America. He is at present engaged in field studies in Central America but will shortly return to his position as assistant professor in the geography and history departments of the University of Washington at Seattle. DR. VISHER, professor of geography at Indiana University, is currently engaged upon a projected climatic atlas of the United States, to which the present study is a contribution. He is the author of several articles in the *Review*, the most recent of which is "Torrential Rains as a Serious Handicap in the South" (Oct., 1941). MR. BAAR is a practicing architect in Seattle. During the war he assisted in planning civilian expansion in the Puget Sound area. His present paper is an outgrowth of his interest in the correlation of the mathematical and visual expressions of trigonometrical formulae.

MR. HITCHCOCK is Assistant Director of the American Geographical Society and head of its Department of Hispanic American Research. DR. KISS, until last summer curator of maps in the William L. Clements Library at the University of Michigan, is now assistant professor of geography at that university. His interest in the political and economic geography of Central and Eastern Europe is demonstrated in "Political Geography into Geopolitics: Recent Trends in Germany" (*Geogr. Rev.*, Oct., 1942) and "Rural Problems of Central and Southeastern Europe: A Review" (*ibid.*, Apr., 1945) as well as in his present review of recent publications on Italian boundary problems.

GEOGRAPHICAL RECORD

NORTH AMERICA

THE DISMAL SWAMP CANAL. The evolution of "the oldest surviving artificial waterway in the United States" from a shallow ditch suitable for flatboats to a major link in the seaboard canal system is the theme of a study by Alexander Crosby Brown (The Dismal Swamp Canal, *Amer. Neptune*, Vol. 5, 1945, pp. 203–222 and 297–310, and Vol. 6, 1946, pp. 51–70). Lieutenant Brown, of the Office of Naval History and corresponding secretary of the Mariners' Museum, Newport News, leaves little for future authors to add to the historical record, which extends from 1728, when a Dismal Swamp canal was proposed, to 1899, when the canal was enlarged to substantially its present form. The year 1793 is suggested as marking the actual beginning of the canal, though it is pointed out that other dates were no less significant—1826, for example, when shoal-draft ships were first passed between the lower James River and Albemarle Sound. This event signalized a turning point in the development of the canal. The improved canal, long recognized as a necessity for the shipment of cypress logs from Dismal's "vast sponge," entered its service as a waterway for through shipments in large vessels. Interest of the federal government in the canal was heightened by the nearness of its northern approaches to the Elizabeth River navy yard.

A major event of the canal-building period was the construction of the shorter Albemarle and Chesapeake Canal, connecting the same bodies of water. Dismal Swamp Canal survived this competition, and also complaints of property owners that it was causing desiccation of their lands. "More people were served by the canal than were harmed by it," says the author in explanation of its longevity. In carefully prepared accounts such as this one, minor flaws stand out more boldly than in papers of ordinary attainment. For example, the surveys of the rival canal route in 1838 were less a personal contribution of Lieutenant Colonel J. J. Abert (incorrectly spelled here, as in many other papers, Albert) than the work of the Corps of Topographical Engineers, of which Abert was then chief. Doubtless Abert had personal knowledge of the area, as he did of other parts of the country whose surveys he directed until 1861, but the report on these particular surveys is signed by James Kearney of the topographical bureau.—RALPH H. BROWN

A REVISED DATE FOR SUNSET CRATER. In the *Geographical Review* for October, 1932, there appeared a paper by me entitled "Sunset Crater: The Effect of a Volcanic Eruption on an Ancient Pueblo People." Since then much has happened; many other prehistoric sites have been excavated, and dozens of charcoal fragments recovered from them have been dated by the tree-ring method. Furthermore, new methods of ceramic analysis have contributed much to the dating of the eruption. The dating has not been a simple problem of direct correlation; for very few timbers were found under unbroken layers of volcanic ash. The dating depends largely on correlation of dated timbers with certain pottery types found above and below the ash layers with dated timbers from sites with similar pottery complexes outside the ash-fall area. For this reason additional information from other sources has affected the conclusions on the date. In the above-mentioned paper I suggested that the eruption took place after A.D. 700 and before A.D. 875. In 1936 McGregor (J. C. McGregor: Dating the Eruption of Sunset Crater, Arizona, *Amer. Antiquity*, Vol. 2, 1936–1937, pp. 15–26), from additional information, thought that the eruption could not

have been before A.D. 875 or after A.D. 910 and suggested A.D. 885 as the probable date. Since McGregor's paper was published, still more information has become available, which makes it appear that the eruption could not have taken place before A.D. 1046 or after A.D. 1070 and probably took place between A.D. 1066 and 1070, as I explain in detail in "A Revision of the Date of the Eruption of Sunset Crater" (*Southwestern Journ. of Anthropol.*, Vol. 1, 1945, pp. 345–355). These new dates not only agree with tree-ring and ceramic data but make a number of events in the history of the people of the San Francisco Mountain area that had been hard to explain with the earlier dates appear more reasonable.—HAROLD S. COLTON

THE POCHTECA: MERCHANTS OF PRE-COLUMBIAN MEXICO. The last decade has seen a great increase in the attention paid in Mexico to studies in the social sciences. So far, anthropology seems to have made the most rapid progress, an impression supported by the recent appearance of a new monograph series, *Acta Anthropologica*, published quarterly by the Sociedad de Alumnos de la Escuela Nacional de Antropología. The first number is devoted to a study of the role of merchants in the social structure of pre-Columbian central Mexico (Miguel Acosta Saignes: Los Pochteca: Ubicación de los mercaderes en la estructura social Tenochca, *Acta Anthropologica*, Vol. 1, No. 1, Mexico, D.F., June, 1945).

Among the Tenochca, the most important of the Aztec groups, whose capital was Tenochtitlán, the precursor of Mexico City, there was a group known as the *Pochteca*, who lived in designated areas, had special deities, and were the bearers of a distinctive series of cultural attributes. The Pochteca were traders who carried on an active external commerce; they were especially charged with the buying and selling of slaves. They were not the only merchants; much of the activity in the market places was carried on by people who made goods or raised produce for sale.

A study of commercial activity among the Aztecs helps explain the rapid expansion of the Aztec state from the fringes of Lake Texcoco to the empire found by Cortes. The Pochteca traded in advance of military conquest, and they gathered information about distant areas that often led to speedy subjugation by force. Two groups functioned among the Pochteca: those who stayed at home, including the elders and some women, who did their trading by proxy; and those who went on the expeditions. Acosta speaks of the latter almost in the sense of spies or advance agents. Occasionally they conquered towns on their own initiative, for they often traveled in considerable numbers. On their trading expeditions the merchants of Tenochtitlán usually joined forces with merchants from a series of other towns to whom they considered themselves related in some way, perhaps because of their profession or possibly through a belief in a similar origin. At other times they founded new towns, presumably as trading posts, among which may be mentioned Querétaro and Tecpatepec. As mediums of exchange the Pochteca used several articles that were already acquiring a fixed value and thus functioned as money: *mantillas* (standardized strips of cotton cloth), tubes filled with gold dust, rich feathers, little axes of copper, and, especially, cacao beans, which were the commonest medium of exchange.

In the Aztec social organization the Pochteca had the rank and prestige of gentlemen. They wore special clothes, had private lands of their own, and were exempt from paying tribute in the form of personal service except in time of war. On their return from successful trading expeditions they were awarded special honors. Only they, along with warriors and nobles, had the right to private lands, the lower members of Tenochca society having only

communal lands. It is evident that the merchants of Tenochtitlán were gradually emerging into a distinct social stratum based on property and the acquisition of wealth.

Acosta discusses at some length the possible locations of the areas given over to the Pochteca, the *barrios de mercaderes,* as mentioned by Sahagún. He also speculates about the origins of the mode of organization, rites, and customs of these specialized traders and advances the hypothesis that the Pochteca represent an intrusion of ethnically differentiated migrants from the Gulf coast who were incorporated into Tenochca society. His summary of Pochteca activity, gleaned from scattered early accounts, is valuable, but it would seem from his monograph that our present information does not permit valid and convincing generalizations regarding the ultimate origins of the Pochteca, nor does it permit more than a partial solution of the problems of specific localization. Our knowledge of the cultural geography of pre-Conquest Mexico is still in its first stages.—HENRY BRUMAN

SOUTH AMERICA

THE EASTERN SUBURBS OF SÃO PAULO. A detailed field study of the eastern suburbs of São Paulo City by Aroldo Edgard de Azevedo gives us new information on the close interrelations of rural and urban life on the margins of Brazil's great industrial metropolis, a city of 1,450,000 (estimated 1945) population (Subúrbios orientais de São Paulo, São Paulo, 1945). Attention is focused on the eastern suburbs, along the line of the railroad (*Central do Brasil*) leading to Rio de Janeiro. Similar suburbs extend southward along the São Paulo railway, which connects with Santos, but on the other sides of the city expansion is restricted by physical barriers and by remoteness from the main lines of travel.

Three kinds of economic function are distinguished in the eastern suburbs. The commonest is, of course, residential. Another is agricultural; i.e. truck and flower gardening. In the last 25 years a zone of intensive truck gardens has developed on the outskirts of São Paulo. The chief products are potatoes, maize, rice, beans, manioc, and fruit. A large proportion of the people engaged in this kind of work are Japanese. In the eastern zone the Japanese are concentrated around Itaquera. The third economic function is that of manufacturing industry. In the clay-filled valley of the Tieté there are many small tile and brick works, chiefly for the production of construction materials. The larger industries in these suburbs include the chemical works in Penha. Such industries are dependent on electric power; the residential suburbs, however, extend eastward beyond the end of the power lines, where people still use kerosene lamps and where the local motion-picture theater must depend on Diesel power to generate its electricity.

The story of the spread of urban influences is closely related to the increasing speed and cheapness of travel and transportation by railroad and, more recently, automobile highway. The mixture of ancient and recent settlements set against a background of rolling hills and swampy valleys has produced a landscape of great diversity—a small mosaic of many different landscapes. Of antiquarian interest are the numerous almost unchanged churches in the remoter places, such as the sixteenth-century chapel of São Miguel.

Aroldo de Azevedo's thesis is a fascinating story of new settlement against older settlement, with many details of interest for the student of urban growth. And it is also another demonstration of the high standard of professional competence required of students of geography in the universities of Brazil.—PRESTON E. JAMES

THE LOMAS OF THE PERUVIAN COAST. Since the earliest chronicles, descriptions of the coastal region of Peru have rarely failed to mention the *garúa,* the banks of fog and mist that hang over the desert coast in winter from May to September, frequently obscuring the sun for weeks at a time and clothing the coastal hills with grasses that provide pasturage just when the Andean streams that water the coastal valleys are at their lowest. Not until recently, however, have any organized experiments been carried out to determine whether the moisture that supports a seasonal, spontaneous growth of native grasses could also support certain agricultural and forest crops. Some experiments in wheat growing by "dry farming" methods were begun in 1930 on the Lomas de Lachay in Chancay Province, Department of Lima, by the Dirección de Agricultura, Ganadería y Colonización, and these were followed in 1932 by experiments in tree planting. So successful were the latter that in April, 1940, a government decree was issued providing for a comprehensive program of studies and tests to be concentrated on government lands in the Lomas de Lachay (see "Lomas de la costa," *Colonias y Foresta,* Vol. 1, Nos. 2 and 3, Dirección de Asuntos Orientales, Colonización y Terrenos de Oriente, Lima, 1944, pp. 32–41). Between that date and June 10, 1944, 50.20 hectares were successfully planted with a total of 165,563 plants and trees of five different genera—casuarina, eucalyptus, agave, acacia, and a variety of thorn. A species of agave, the *froucroya,* was found to be particularly well suited to ecological conditions on the Lomas de Lachay. Studies of moisture conditions of the soil as the plantings grew revealed that the greatest condensation of moisture as regards both quantity and depth of penetration occurred under the casuarina plantings, that the condensation increased as the trees grew, and that the moisture condensed and retained was increased not only under the trees but in unplanted areas adjacent to them.

EUROPE

BRITISH PLANNING SCHEMES. In the October, 1946, number of the *Geographical Review* (pp. 609–612) there appeared a list, compiled by Professor L. Dudley Stamp, of British town and regional planning schemes prepared since 1940. Two additions to this list may be noted: a "Memorandum on Cumberland, With Special Reference to the Development Area," written by Professor G. H. J. Daysh of the University of Durham and issued by the Cumberland Development Council, Whitehaven, 1945; and a pamphlet on "The Northern Region" (Northumberland, Durham, and the North Riding of Yorkshire) published by the North East Development Association in May, 1946. Both publications emphasize the need for coordinating governmental and private action in planning: "On the one hand, local authorities and industrialists are able to make valuable contributions, while on the other it is imperative that they be advised of the broad lines of any development plan if discordancies are to be avoided." The pamphlet on Cumberland is accompanied by a sketch map on the scale of 4 miles to the inch illustrating the main suggestions outlined in the memorandum.

FURTHER NOTES ON GERMAN GEOGRAPHY. Information on the present status of geography and cartography in Germany continues to filter in. In the July, 1946, number of the *Geographical Review* it was reported that the Russians had moved the Justus Perthes plant to Kiev (T. R. Smith and L. D. Black: German Geography: War Work and Present Status, Vol. 36, pp. 398–408), but a later report states that the firm remains in operation on a limited

scale at Gotha and has recently published a map showing the occupation zones on the scale of 1 : 1,500,000.

The Bibliographisches Institut in Leipzig, which resumed operations in the spring of 1945, now has a staff of some 150, under the direction of Dr. Rudolf Franz. Dr. Edgar Lehmann, formerly head of the cartographic work, is the present business manager.

The Deutsche Geographische Gesellschaft has been reorganized under Professor Wilhelm Credner, with statutes revised to conform with the new regime. Its program includes plans to establish a first-class research periodical that will adequately represent German geography both at home and abroad, to aid the development of geography in the universities and high schools, and to promote the use of geography in reconstruction activities.

The Reichsamt für Landesaufnahme, which before the collapse of Germany had been dispersed to various centers in Thuringia and Saxony, underwent a series of changes in the summer of 1945. The division for regional geography (Abteilung für Landeskunde) was moved to Scheinfeld, the geodetic division to Bamberg, and the key personnel, together with a few cartographers and lithographers, to Fürstenhagen—all in the American Zone. The photogrammetric division was sent to Berlin, where it was largely disbanded. So far as can be ascertained, the work of the bureau is still being carried on in these localities, though the director, Dr. Nowatzki, is now in Berlin attempting to coordinate the divisions and restore the whole to operating efficiency.

The Abteilung für Landeskunde, as the article cited above indicates, represents the greatest actual and potential force in German geography today. It was re-established financially in December, 1945, with a mandate to initiate and coordinate geographical research in Germany and has now been organized into eleven subdivisions, each responsible for a certain part of the program. Work in progress includes the cataloguing of maps of Germany published since 1939; cataloguing of geographical literature on Germany published since 1910; preparation of a map of the regional subdivisions of the country on the scale of 1 : 500,000; publication of regional descriptions (*Kreislandeskunden*) of Scheinfeld and a number of districts in Bavaria; writing of descriptions to accompany the Bamberg and Stuttgart sheets of the 1 : 200,000 map; and preparation, by request, of a series of food maps based on current statistics for *Gemeinden* (minor civil divisions). Publication of a "Geographischer Handweiser," a new edition of the "Kreisgrenzenkarte des westlichen Deutschlands" on the scale of 1 : 1,000,000 (with the eastern boundary at the Oder-Neisse line), and a geographical encyclopedia of Germany is scheduled for the future, as is the resumption of "Berichten zür deutschen Landeskunde" and "Forschungen zür deutschen Landeskunde." The present professional staff includes Professor Emil Meynen (head of the division) and Drs. Gottfried Pfeifer, Erich Otremba, Ingrid Mathiesen, and Angelika Sievers. Dr. Dietrich Gurlitt, who joined the staff at the time of the reorganization, left in the spring of 1946 to go to the University of Freiburg; Dr. Norbert Fischer, who joined the Abteilung in February of 1946, was requested by the local authorities to teach in the new high school at Scheinfeld. These two men were replaced by Dr. Siegfried Schneider (student of Norbert Krebs) and Dr. Rolf Schmidt (student of Karl Troll).

The death of a number of eminent German geographers has been reported. These include Gustav Braun (November, 1940), Bruno Plaetschke (April, 1942), Hans Meyer (March, 1945), Karl Sapper (March, 1945), and Hans Schrepfer (March, 1945).—LLOYD D. BLACK

AFRICA

AFRICA'S MOUNTAINS. Several recent articles on Kilimanjaro (about 19,590 feet) and Mt. Kenya (17,040 feet), the two highest summits in Africa, furnish much valuable information on their glaciers and volcanoes, and also on their flora and fauna, which range from tropical to alpine.

The summit of Kilimanjaro's highest cone, known as Kibo, was first reached by Hans Meyer in 1889. Though the volcano was climbed a number of times after that, it was considered to be extinct until 1942, when J. J. Richard discovered the presence of active fumaroles in the inner crater. On this ascent, and on two later ones, Richard studied the whole summit area in detail and made close observations of the fumarolic activity (Volcanological Observations in East Africa: II—Kilimanjaro: Kibo's Fumarolic Activity in 1942–43, *Journ. East Africa Nat. Hist. Soc.*, Vol. 18, 1944–1945, pp. 1–12; Kilimanjaro: Crater Fumaroles of Kibo and Seismic Activity during 1942–45, *Nature*, Vol. 156, 1945, pp. 352–354). In 1944 he initiated monthly temperature readings in a number of fumaroles and established four rain gauges at elevations ranging from 7200 to 16,000 feet. Later he added two snow gauges at 16,000 and 19,100 feet.

P. C. Spink (Further Notes on the Kibo Inner Crater and Glaciers of Kilimanjaro and Mount Kenya, *Geogr. Journ.*, Vol. 106, 1945, pp. 210–216), in addition to observing the volcanic phenomena on his three ascents of Kilimanjaro, carefully studied the glaciers and residual ice masses, remnants of a large and unbroken icecap that in former times filled the crater and flowed down the sides of Kibo Peak to elevations as low as 11,000 to 12,000 feet. Recession of these glaciers and ice masses has been reported by various individuals during the last 45 years. Recently, however, the rate of lateral and terminal shrinking and ablation seems to have increased and is described as "startling." Snow accumulation is apparently far less than enough to offset the annual melting and is probably not adequate to maintain any glaciers on the summit. It has not yet been possible to determine what effect the fumarolic activity may have on the ice, but further detailed periodic observations may yield some interesting information. The glaciers of Mt. Kenya, which Spink visited in 1944, were also found to be shrinking rapidly. There are now ten separate small glaciers on the mountain. Four glaciers have apparently disappeared since 1926 and an additional one since 1893, when a total of 15 was reported.

Richard states that meteorological and volcanological observations are being continued on Kibo, and Spink urges that the glaciers of both mountains be observed and photographed each year so that details of their recession and of changes in the condition of the ice may be recorded. It is to be hoped that this can be accomplished, in spite of the obvious difficulty of carrying out systematic observations on these relatively remote mountains and at such high elevations. Apparently an excellent beginning for a postwar program has been made by enthusiastic and competent observers.

R. E. Moreau contributes a valuable summary of existing knowledge on the biology of Kilimanjaro and Mt. Kenya and a bibliography of the latter (Kilimanjaro and Mount Kenya: Some Comparisons, With Special Reference to the Mammals and Birds; and With a Note on Mount Meru, *Tanganyika Notes and Records*, No. 18, 1944, pp. 28–59; Mount Kenya: A Contribution to the Biology and Bibliography, *Journ. East Africa Nat. Hist. Soc.*, Vol. 18, 1944–1945, pp. 61–92), and C. Gillman has provided an exhaustive list of references and maps

of the former (A Bibliography of Kilimanjaro, 1944, *Tanganyika Notes and Records*, No. 18, 1944, pp. 60–68). Such compilations are of inestimable value not only to the scientist and the mountaineer but to those concerned with other aspects of these mountains and the surrounding areas.

COLONIZATION AND SETTLEMENT IN PORTUGUESE AFRICA. Review of Portugal's successful colonization and development of Brazil, the Azores, and other regions suggests the need for investigation as to why its two large African colonies, Angola and Mozambique, have not progressed to the same extent (Moura Braz: Algumas notas sôbre colonização e povoamento, *Bol. Soc. de Geogr. de Lisboa*, Ser. 61, 1943, pp. 329–356).

Both territories occupy a favorable position between the great interior plateau and the ocean. Their wide range of altitude and climate gives them a diversity of natural products, from tropical crops such as bananas, coconuts, and cacao to cereals and temperate-zone fruits. Sugar cane, sisal, and millet are grown; cotton cultivation could be greatly extended; and there are innumerable possibilities for livestock production.

The lack of progress cannot be attributed to unfavorable climate; for extensive elevated plateaus in both Angola and Mozambique afford reasonably comfortable conditions, and even the more tropical areas are at least as well suited to European settlement as the lower Amazon and Panama.

Certainly, then, these two colonies would seem to have the capacity to absorb a large European immigration, besides maintaining their native populations on a considerably higher scale than at present.

In the author's opinion the explanation of the situation is to be found in the relation of the state to the colonies. The home government has its necessary and proper functions of providing credit facilities, means of transportation, and markets for the colonist and of rendering the normal technical assistance he requires. From this point on, the development should be "natural," as in Portugal's prosperous colonies. In carrying out a colonial program, governmental participation that introduces artificiality or compulsion into colonial affairs precludes the best results. The pioneer in a far land requires a free hand in overcoming his obstacles; he must learn by trial and error, even though this involves failure.

The colony of Barão de Antonina, in the state of São Paulo, Brazil (described in the *Geographical Review* of April, 1940), is cited as a good example of natural and spontaneous systematic settlement with minimum intervention by the state. Certain settlements in southern Angola have likewise succeeded by following such a course, notably Lubango, which grew in 50 years from a nucleus of fewer than 400 Europeans to a present population of more than 6500 Europeans in addition to mixed and native inhabitants. On the other hand, the penal colony of Mochico, the state-managed colony of Umbeluzi, and similar efforts, in which government aid and supervision were overstressed, resulted in failure.—William E. Rudolph

COLONIZATION IN THE NIGER ELBOW. At a time when famine and destruction are widespread, it is particularly interesting to read of the efforts and plans of the Office du Niger for the colonization of large areas near the elbow of the Niger River (Jean Gabus: La colonisation de la boucle du Niger, *Bull. Soc. Neuchâteloise de Géogr.*, Vol. 51, No. 2 [N.S. No. 3], 1945, pp. 1–41). The project is, in fact, one of rehabilitation. Geographers and travelers of the fourteenth, fifteenth, and sixteenth centuries tell of wealthy and populous communities that flourished here. The subsequent decline of the region is believed to have

been due to the gradual silting up of various distributaries as a result of a slow shifting of the river toward the south (probably due to the action of dominant winds), so that during the floods (mid-June to mid-January) about half the water of the upper Niger was lost in swamps and aimless creeks. The Office du Niger, founded in 1932, now plans to bring back to life about a million hectares, capable of supporting about a million settlers, through irrigation, immigration, and agricultural planning. Plans for the future call for the reclamation of 10 million hectares.

A dam at Sotuba, constructed by the Service du Niger (predecessor of the Office du Niger) and finished in 1929, irrigates 5837 hectares by means of the Sotuba Canal. Another at Sansanding, finished in 1942, supplies 800,000 hectares through the Sahel and Macina Canals and will, it is hoped, supply a third canal, the Karadougou. (The Sahel and Macina Canals are shown on a map of the Niger Irrigation Project in R. H. Forbes: The Trans-saharan Conquest, *Geogr. Rev.,* Vol. 33, 1943, pp. 197–213, Fig. 21; for a map of the entire region see Géographie Universelle, Vol. 11, Part 2, 1939, p. 466.) Plans are also being made for the development of the lacustrine region and areas along the lower Niger. Voluntary immigrants—confined to native Sudanese, already adapted to the climate—are attracted to the irrigated land from overpopulated areas in other parts of the Sudan and are given free transportation to the new colony. An average family (10 to 12 persons) is provided with 4 cabins, about 10 hectares of cleared land, a reserve of food until the first crop is ready, some farming equipment, 2 to 4 oxen, and a cow or two. Larger equipment is collectively owned and operated. A yearly tax of about a quarter of the crop is imposed for gradual repayment of these advances. A second portion of the crop is put aside for the settlers by their agricultural cooperatives as a reserve for food and seed (to counteract frequent improvidence), and the rest is turned over to the settlers for selling, either through the cooperatives or directly, as they prefer. Net profits of more than two million francs were realized in the Sotuba area in 1939, or about 4000 francs per average family, and production seems to be increasing. Before settlers are received, intensive research is carried out by experiment stations, which select suitable crops. Rice, mainly for local consumption, dominates in the Sotuba and Macina areas; the Sornavary variety, producing from 1800 to 2000 kilograms per hectare, the Dissi, producing about 3 tons of paddy per hectare, and the Sikasso and the Kassoun, producing about 4 tons of paddy per hectare, were selected as the most suitable varieties. For export and some local use, cottons such as the Allen and N'Kourala, yielding from 1200 to 1800 kilograms per hectare, are grown mainly in the Sahel and Macina areas. Peanuts constitute a third important crop, and cattle and a few sheep help provide meat, milk, wool, and fertilizer. It is believed that exports from the Niger region will amount to more than a billion francs a year and will provide, among other things, much needed cotton for France.

One of the main problems seems to be the education of the settlers, who have everything to learn about the use of a plow, the selection and care of livestock, the maintenance of the irrigation systems, and modern methods of cultivation. Instructors and administrators, mostly from the École coloniale de Marseille, must use great tact and understanding in dealing with the many diverse peoples, each with its customs, religion, language. A policy of association in a quasi-collectivist system, rather than assimilation, is being followed, since it is believed to give better results and to respect to a greater extent the dignity of the individual settler.

ASIA

LAND USE IN THE SZECHWAN BASIN. The extraordinary intensity of agricultural land use in the Szechwan (also commonly called the Red) Basin of China is clearly evidenced in a critical evaluation of the region by Dr. Charles Y. Hu (The Agricultural and Forestry Land-Use of Szechuan Basin [Diss., Ph.D., Univ. of Chicago, 1942], Chicago, 1946). Interplanting, intensive fertilization, special terracing methods—"probably nowhere in China has a higher and more extensive utilization of slope land been made"—and long-established irrigation practices are characteristic features.

In the great diversity of its products the basin is virtually a China in miniature. Dr. Hu distinguishes five major agricultural areas. The first is the rich grain-farming Chengtu Plain, where in a normal year 15 million piculs of rice and 8 million piculs of wheat are produced (a picul is 133.4 pounds). Other cereals, rapeseed, tobacco, medicinal herbs, and vegetables are also grown, and the total value of all these crops at prewar prices was a little more than 180 million dollars annually. Farms on the Chengtu Plain are the largest in the basin, averaging 73.1 mow (12.2 acres), as compared with the general average of 16.3 mow (2.7 acres). The second agricultural area, the valleys of the lower To and Fou Rivers, specializes in "commercial" products: it contributes about 85 per cent of the basin's total production of sugar cane, 65 per cent of the cotton, and 55 per cent of the silk. A large part of the necessary foodstuffs is imported. The rugged, dissected northern basin, on the other hand, is a nearly self-sufficient subsistence agricultural area with no single crop predominant. Wheat, rice, barley, millet, potatoes, beans, corn, and other crops are grown for home consumption; the only product that brings in a cash income is medicinal herbs. The eastern area also raises subsistence crops, but it is most important for its production of tung oil, contributing nearly 75 per cent of the total production of the basin. The southwestern area of mixed farming represents a synthesis of the other four, possessing some characteristics of each. The broad valleys of the Min and the Yangtze offer fertile fields for the cultivation of rice, sugar cane, and citrus fruits; the terraced hill lands produce wheat, hemp, barley, corn, and potatoes; the steep slopes furnish tree crops such as tung oil, silk, white wax, tea, and bamboo.

Forestry land use is important in the regional economy. In 1940 tung oil made up as much as 65 per cent of the total export trade of the basin. For many years the oil has been derived from the fruit of the wild trees, but recently plantations have been established and scientific methods introduced. The total annual production in prewar years was about 760,000 piculs, but under the stimulus of war demands production reached 1,140,000 piculs in 1940. White wax, an insect secretion deposited on certain species of trees and shrubs, is another important forest product. Normally, about 20,000 piculs is produced annually. The wax has numerous uses as an ingredient in such commodities as candles, furniture polish, paper glazes, and medicines. Some 4000 piculs of lacquer is also produced annually in the basin. Formerly, about 90 per cent of this was exported to Japan, but it is now used almost entirely within the basin, which has long been noted for its lacquer wares. Bamboo is a fourth valuable forest resource; in fact, it has been estimated that the plant is used in more than 600 different ways within the basin. There are few plantations, but most farmers have small stands of bamboo somewhere on their farmsteads. These not only furnish wood for numerous household and farm uses but act as an erosion preventive as well, the matted, fibrous roots being highly effective in holding soil.

During recent years the basin has been undergoing an economic and technological revolution induced by the war, and it is probable that the immediate future will witness unprecedented progress. Introduction of new varieties, scientific methods of cultivation, advanced irrigation practices, development of transportation facilities, and other such improvements should have far-reaching results in transforming the ancient farm structure into a more effective agricultural economy.

POLAR REGIONS

THE ELEVENTH SOVIET VISIT TO THE NORTH POLE. On September 29, 1945 a Soviet-built plane of the Douglas type left Moscow for the North Pole (D. Karelin: New Flight to the North Pole, *Bull. USSR Geogr. Soc.*, Vol. 78, 1946, pp. 123–124). The plane was under the command of Chief Pilot M. Titlov; the others aboard were a second pilot, a hydrologist, a mechanic, and a radio operator. The purpose was a reconnaissance of autumn ice conditions in the western sector of the Soviet Arctic. The party flew by way of Cape Kosisti (Khatanga Bay), Cape Chelyuskin, and Cape Molotov and returned by way of the New Siberian Islands and the Indigirka region. By crossing an area that was in part unexplored, the plane reached the North Pole on October 2. There was only twilight in the vicinity of the pole, but the air was so clear that visibility was adequate from 10 to 20 miles in all directions.

The flight to the pole required six hours, the return trip to the village of Chekurdakh, near the mouth of the Indigirka, nine hours, covering, in all, some four thousand kilometers. Weather conditions were less favorable on the return voyage, with belts of fog and poor visibility.

The area covered was found to contain many different kinds of pack ice, ranging from the oldest downward. A discovery that would have been startling had there not been a similar one two years before north of the Franz Josef islands was the finding of icebergs in two places, latitudes 83° 20′ and 85° 40′, north of Northern Land. It is thought that the birthplace of the bergs seen on both flights must have been on the eastern shore of Northern Land. In the immediate vicinity of the pole there were huge open leads and other signs of ice movement. It is estimated that the flight diminished by about three thousand square kilometers the unexplored area to the north of Laptev Sea.

The writer of the notice, D. Karelin, made the flight in 1943 on which icebergs were sighted north of Franz Josef Land. He considers the flight of October 2, 1945, to be the sixteenth visit to the North Pole and the eleventh visit by Soviet explorers. His list is given below:

1. R. Peary, April 6, 1909, on foot over the ice from Grant Land.
2. R. Byrd, May 9, 1926, by plane from Spitsbergen.
3. R. Amundsen, May 13, 1926, by dirigible from Spitsbergen.
4. Italian [Nobile] expedition, May 24, 1928, by dirigible from Spitsbergen (on the return voyage the dirigible was wrecked).
5. P. Golovin, May 5, 1937, by plane from Franz Josef Land.
6. M. Vodopianov, May 21, 1937, by plane from Franz Josef Land, landing on the ice with I. Papanin and others who were to winter on the drifting ice.
7. I. Mazurik, May 26, 1937, by plane from Franz Josef Land, with two landings on the ice.
8. V. Molokov, May 26, 1937, by plane from Franz Josef Land, with a landing on the ice.

9. A. Alekseev, May 28, 1937, by plane from Franz Josef Land, with two landings on the ice.

10. V. Chkalov, June 19, 1937, who passed over by plane on the trans-Arctic flight from Moscow to the United States [which landed in Vancouver, Wash.].

11. M. Gromov, July 13, 1937, who passed over by plane on the trans-Arctic flight from Moscow to the United States [which landed near San Diego].

12. S. Levanevsky, August 13, 1937, who passed over by plane on a trans-Arctic flight from Moscow to the United States (the flight was not completed, and the plane was lost without a trace between the pole and the United States [Alaska]).

13. M. Vodopianov, October 7, 1937, by plane from Franz Josef Land at the time of the search for Levanevsky.

14. Y. Moshkovsky, April 4, 1938, by plane from Franz Josef Land at the time of the Levanevsky search.

15. D. McKinley, May 17, 1945, by plane from Iceland.

16. M. Titlov, October 2, 1945, by plane from Cape Chelyuskin, on an ice reconnaissance.

—Evelyn Stefansson

PHYSICAL GEOGRAPHY

GLACIOLOGICAL STUDIES. Under the modest title of "Researches on Snow and Ice, 1918–40" (*Geogr. Journ.*, Vol. 107, 1946, pp. 11–28) H. W. Ahlmann gives an enlightening résumé of the glaciological studies he has made in the past 30 years, beginning in Norway and proceeding across the North Atlantic to Spitsbergen, Iceland, and Greenland.

The first ice body to be investigated by Ahlmann, in 1918–1922, was the Styggedal Glacier in Jotunheim, the high-mountain district of southern Norway. Resisting the lure of the great Jostedal Glacier, "the largest single ice mass on the European continent," he chose for the subject of his studies a small, simple cirque glacier a mile and a half long. Being by temperament inclined to seek quantitative results, he selected, as a mathematician would, a subject as nearly devoid of complicating factors as he could find.

His principal object was to ascertain under what climatic conditions such a glacier exists and what is the nature of its regimen—that is, its hydrological balance expressed in terms of annual income in the form of snow and hoarfrost and of annual losses due to melting and evaporation. To obtain reliable year-round meteorological data, he and his assistant, Eythórsson, overcoming many physical difficulties, built a small observatory on Mt. Fanaråk near by. This was later taken over and enlarged by the Bergen Meteorological Institute.

During the first few years of Ahlmann's studies the Styggedal Glacier was nearly in hydrological equilibrium, its income of water substance being approximately equal to the outgo. But observations have shown that since the beginning of the 1930's its losses have exceeded its income, and that as a result the glacier, like all the other glaciers in Norway, has been growing shorter and thinner.

Ahlmann touches only briefly on his investigations in Northeast Land, in the Spitsbergen archipelago, in 1931. He merely dwells on the fact that the small icecaps on Northeast Land are in a state of decline and stagnation, and, presumably for the sake of brevity, he omits mention of the noteworthy contribution to glaciology that grew out of his temperature measurements at various depths in the ice. Those measurements, it will be recalled, led him to propose a "geophysical classification" of glaciers, based on their internal temperatures and comprising three classes: (1) High-Arctic glaciers, which in their accumulation areas are frozen the year round to depths of at least 100 meters; (2) Sub-Arctic glaciers, which also are frozen to great depths but in summer thaw briefly at the surface; and (3) Temperate glaciers, which in summer are at or near melting temperature throughout their mass. Later

he changed the names High-Arctic and Sub-Arctic to High-Polar and Sub-Polar. The icecaps on Northeast Land he classed as Sub-Polar.

On his expedition to West Spitsbergen, in 1934, Ahlmann was accompanied by Sverdrup, and the two did extremely effective teamwork. By making borings and digging pits at various points on the Fourteenth of July Glacier, Ahlmann determined the thickness and the water content of the annual firn layers, and with the aid of a specially designed device he measured the reduction of the surface by ablation during the summer. Thus he was able to calculate that in the year 1933–1934 the glacier received nourishment amounting to 79 million cubic meters of water and lost a total of 113 million cubic meters. Sverdrup's refined measurements showed, among other things, that 56 per cent of the ablation was due to radiation and 44 per cent to atmospheric convection.

The most comprehensive of Ahlmann's glaciological investigations were those that he made in collaboration with Thorarinsson and Eythórsson on the Vatnajökull of Iceland, in 1936, 1937, and 1938. Advantage was taken of the facts that a fall of ash from a volcanic eruption had covered a large part of the icecap in 1934 and that the resulting ash layer in the firn provided a definitely dated plane of reference. The Hoffellsjökull, an outlet glacier near the east end of the icecap far from the volcanic center, and therefore presumably not affected by volcanic heat, was selected for intensive study. At its extreme head on the ice plateau the ash layer was encountered by drilling, in 1936, at a depth of 26 feet below the surface. Since the autumn of 1935 snow and hoarfrost equivalent to 102 inches of water had accumulated at that spot, and beneath that there was a residue of firn from the winter of 1934–1935 equivalent to 59 inches of water.

Further, borings made at different points on the Vatnajökull disclosed the progressive decrease of accumulation with increasing distance northward from the "Icelandic low," which is, of course, the main source of precipitation on the icecap. During the winter of 1935–1936 there had accumulated on the wet south side of the icecap firn equivalent to 109 inches of water, whereas on the drier north side accumulation represented only 67 inches of water. In spite of this abundance of incoming moisture, the Hoffellsjökull's balance for the year 1935–1936 showed a deficit of 364 million cubic meters. Its balance for the three years 1935–1938 showed a net loss of 284 million cubic meters.

"Perhaps the most important of the general conclusions from our work on Vatnajökull," Ahlmann adds, "is that temperature variations are of more importance to the life of a glacier than variations in precipitation. Also, that the ablation mainly depends on convection . . . ; radiation proved to be of less significance." These statements, the present writer believes, were, however, intended to apply chiefly to glaciers in maritime climates; for, as Sverdrup's measurements on West Spitsbergen showed, in the colder and drier climate of that island radiation is more effective than convection.

Ahlmann's latest studies were made in 1939 on the Fröya Glacier, on Clavering Island, in northeastern Greenland. There, again, he selected for study a simple ice stream of moderate proportions originating in an independent and circumscribed gathering basin. Because of the "arctic continental" climate of this part of Greenland, the Fröya Glacier receives but little snow. Ablation is caused largely by radiation, though toward the end of the summer convection becomes more effective than radiation. The ice stream appeared to be frozen to its bed, immobile, and "almost dead." Ahlmann classed it as Sub-Polar.

Of special interest to him were the strong terminal moraines that curve around the

front of the ice mass and evidently mark the farthest limit it attained in fairly recent time, after its reduction in size, or total extinction, during the post-Pleistocene "warm period," which now appears to be established beyond possible doubt. All the other local glaciers in northeastern Greenland have analogous terminal moraines of decidedly youthful appearance, and Ahlmann believes they may date from the second half of the eighteenth century and the beginning of the nineteenth, which were the periods of maximum glacier extension in Norway and Iceland.

To the present writer, however, it seems more likely that the latest readvance of the Fröya Glacier occurred less than 100 to 120 years ago, in view of the fact that the ground between the terminus and the moraines is still wholly bare of vegetation and the rocks in the barren zones that flank the glacier throughout most of its course have not even been invaded by lichens. Plants of that type may be slow in establishing themselves in the cold and dry climate of Clavering Island, yet it seems hard to believe that they would require more than a century in which to make a start. On purely climatological grounds, moreover, it may reasonably be supposed that the climatic fluctuations that caused the glaciers in Iceland to readvance sharply about 1850 and 1890 made themselves felt in eastern Greenland also.

In conclusion Ahlmann cites several evidences of a decided amelioration of climate, and of a warming of ocean waters, in the Arctic regions, which have been reported recently by Russian and Scandinavian observers. Those facts harmonize with the numerous evidences of gradually increasing temperatures that are being reported from other parts of the world—from the Southern Hemisphere as well as from the Northern, and even from regions close to the equator.—FRANÇOIS E. MATTHES

CLIMATIC CHANGE. "Some Recent Contributions to the Study of Climatic Change" by Gordon Manley (*Quart. Journ. Royal Meteorol. Soc.*, Vol. 70, 1944, pp. 197–219) is an "exploratory or reconnaissance survey" of findings of the last few years, especially by British and Continental workers.

One of the principal means of determining past climatic changes is the study of the behavior of glaciers, so extremely sensitive are they to even minor changes. In recent decades precise and detailed observations of glaciers and analyses of meteorological records have furnished much valuable information. Outstanding work has been done by the Scandinavians, among whom Professor H. W. Ahlmann has been the leader. His studies on the economy of glaciers, carried on over a period of 25 years, principally in Norway, Spitsbergen, and Iceland, are highly significant. It is to be hoped that such studies will be expanded and will also be undertaken in other parts of the world. In North America, for example, centers of glaciation in the Western States, Canada, and Alaska provide excellent opportunities for detailed and systematic observations.

From such studies and, for earlier postglacial time, from analyses of pollen from peat bogs, our knowledge of the climate of the last few thousand years is continually being enlarged. Evidence from many sources indicates that a warm climate, first dry and then somewhat more humid, prevailed from about 7000 to 3000 B.C. (For one of the most recent studies leading to this conclusion see H. P. Hansen: Postglacial Forest Succession and Climate in the Oregon Cascades, *Amer. Journ. of Sci.*, Vol. 244, 1946, pp. 710–734.) During this period glaciers in most parts of the world were probably smaller than now. Cooler moist conditions

followed, probably accompanied by glacial expansion. Within historical time there have been similar variations from warmer to cooler conditions: important glacial maxima occurred in the Alps and Scandinavia in the seventeenth, eighteenth, and nineteenth centuries. During the last half century, however, there has been a general recession, the rate of which has for many glaciers increased in the last two decades. Melting of the Norwegian snow fields is believed to be more extensive now than it has been since the early centuries of the Christian Era, and some of the glaciers are reported to be retreating "catastrophically." Recession in Iceland has been very rapid since 1930. From the Soviet Union come reports that in Central Asia the glaciers are now receding rapidly, and some are facing extinction. Reports from Africa indicate an accelerated melting of the glaciers on Kilimanjaro and Mt. Kenya. Some North American glaciers have also behaved in this manner, others have not—which presents a problem of interest. And lastly, the whole Arctic seems to have been experiencing a rise in temperature since about 1921.

Although the fluctuations of the earth's glaciers may seem to have very little to do with the course of human affairs, the present and past climatic changes they reveal undoubtedly have had and will have an effect on the development of human beings and their social and economic organization. Mr. Manley's paper serves as a valuable summary of some of the recent studies in this complex and to some extent controversial field of inquiry and makes clear the need for continued investigations by meteorologists and glaciologists.

HUMAN GEOGRAPHY

THE FIRE DRIVE AND THE EXTINCTION OF THE TERMINAL PLEISTOCENE FAUNA. "The subject of extinction has a perennial, an almost morbid fascination," writes Professor Loren C. Eiseley. "The total disappearance of a species, of a unique and never-to-be-duplicated genetic pattern, has in it, moreover, something of the mystery that lingers about the origins of those same patterns. And when, in addition, that disappearance is found to be correlated in time with the first human intrusions into the New World, then, indeed, our speculations multiply" (The Fire-Drive and the Extinction of the Terminal Pleistocene Fauna, *Amer. Anthropologist,* Vol. 48 [N.S.], 1946, pp. 54–59). However, in the last four decades only two new theories have added "anything of a very startling nature" to Henry Fairfield Osborn's exposition of "The Causes of Extinction of Mammalia" (*Amer. Naturalist,* 1906). One of these is the fire-drive theory advanced by Carl O. Sauer in "A Geographic Sketch of Early Man in America" in the October, 1944, number of the *Geographical Review;* the other is Sewall Wright's gene-fixation theory.

Professor Eiseley finds the fire-drive theory provocative, raising questions as well as answering them. He points out, for instance, that not only the large, clumsy animals, easy victims, disappeared but more mobile species also, including several birds. On the other hand, the catastrophic activities of the early hunters did not wipe out the bison and the antelope. The high frequency in campsites of bones of the large mammals can be explained in other ways than solely as a result of fire drives. Certain predators became extinct while prey still survived. Some forest dwellers—the eastern mastodon, for example—perished simultaneously with the animals of the plains. From a consideration of such matters Professor Eiseley concludes that no one specific explanation can be applied to the complex problem of mammalian extinction. Man probably played a part. "But something which we may

suspect as being at least partially linked with the mysterious climatic changes of the closing Pleistocene had already started that rich fauna down the road to disappearance. . . . The Pleistocene still keeps its mystery, probably because it has no single secret to lose."

GEOGRAPHICAL NEWS

FOUNDING OF THE BRITISH GLACIOLOGICAL SOCIETY AND THE JOURNAL OF GLACIOLOGY. From London comes the announcement of the founding of a new scientific body to be known as the British Glaciological Society. It was formally organized by a group of glaciologists, Arctic and Antarctic explorers, geographers, geologists, climatologists, physicists, and others interested in the study of snow and ice, meeting at the Royal Geographical Society on October 22, 1945. The meeting was presided over by Gerald Seligman, well-known authority on snow and its transformation into firn and glacier ice.

The new society is an outgrowth of the Association for the Study of Snow and Ice, which was organized in 1936 by the British members of the International Snow Commission under the leadership of Seligman and which was active until its members became scattered as the result of war duties. Like its parent body, the society seeks, as its primary object, "to encourage research on, and stimulate interest in, the practical and scientific problems of snow and ice." It thus aims to cover a wide range of studies, investigating such problems as the behavior of ice crystals under applied stresses; the roles played by snow and ice as precipitation, as agents of erosion, and as modifiers of climate; the devising of methods for the prevention of snow avalanches and of debacles in frozen-over rivers; and the designing of vehicles for oversnow travel and of skis for airplanes. The annual Survey of Snowfall in the British Isles, instituted in 1936 by the Association for the Study of Snow and Ice, has been resumed. The new Society is also "the responsible body for nominating members of the British group in the International Commission on Snow and Glaciers," one of the commissions of the International Union of Geodesy and Geophysics.

From an initial membership of 36 the society has grown during the first year of its existence to more than 100 members, including residents of the United States, Canada, Sweden, Switzerland, South Africa, Australia, and New Zealand. Membership is open to all who have scientific, practical, or general interest in problems connected with snow and ice in their varied forms. The society may be addressed in care of the Royal Geographical Society, Kensington Gore, London, S.W.7.

Meetings are held quarterly in London, Cambridge, or some other place in England. At the first meeting the following officers were elected: president, Gerald Seligman; vice-president, J. M. Wordie; executive committee, L. W. C. Bonacina, A. R. Glen, H. MacRobert, Gordon Manley, R. Moss, N. E. Odell, Brian B. Roberts, Mrs. G. W. Rowley, and K. S. Sandford.

The need for a suitable journal for the publication of its scientific transactions was soon felt by the new society. It was realized, further, that if such a journal could be adequately supported, it might also serve as a general forum in which glaciologists from all parts of the world might discuss their problems. The *Zeitschrift für Gletscherkunde*, the only purely glaciological magazine that has existed in past years, ceased publication early in the war. The demand for a journal devoted entirely to glaciology is rapidly increasing, and the hope has been expressed, not only in Britain but also in the United States and in continental Europe, that the British Glaciological Society would undertake to bring such a journal into being.

From recent advices it appears that the society has succeeded in securing the necessary financial support and that the first number of a *Journal of Glaciology* will soon be ready for publication. The *Journal* will contain the papers read before the society and the accompanying discussions. In addition, it is intended to be the general vehicle for contemporary glaciological thought, and articles on all types of glaciological research, scientific and practical, will be welcomed. Correspondence is invited. Short notes on current glaciological literature will be included in each number.—François E. Matthes

PHOTOGRAPHS AND NOTES ON ALASKAN GLACIERS. The Research Committee on Glaciers of the Section of Hydrology of the American Geophysical Union, François E. Matthes, chairman, has transferred its collection of photographs of Alaskan glaciers and accompanying maps and notebooks from the Library of Congress, where it has been on deposit since 1932, to the American Geographical Society of New York. This collection, which comprises more than five thousand dated photographs, has great value as a visual record of the changes in length and volume of the glaciers as the result of climatic fluctuations in the past fifty years. The material has been brought together largely through the efforts of William O. Field, Jr., a member of the staff of the American Geographical Society and the vice-chairman of the Research Committee on Glaciers. Mr. Field is custodian of the collection and is responsible for its orderly arrangement and the systematic labeling of the individual photographs.

The collection consists in large part of photographs and notes taken by members of expeditions and by individual explorers and scientists. Much of it was received in the form of donations. From the late Dr. C. Hart Merriam the committee received the collection of photographs of the Harriman Alaska Expedition of 1899. From the late Dr. Harry Fielding Reid it received the photographs and glass negatives of his work in Glacier Bay in 1890 and 1892, and subsequently from Mrs. Reid the rest of his photographs and field notebooks. Dr. William S. Cooper has contributed the photographs he took in Glacier Bay in 1916, 1921, 1929, and 1935. From Colonel Lawrence Martin have come more than three thousand photographs of glaciers along the coast of Alaska that he and his associates took at different times between 1904 and 1913 and that he has collected from other sources. Mr. Field has contributed his own collection of photographs, taken by him and his associates on visits to the Alaskan coast in 1926, 1927, 1931, 1935, and 1941. Important photographs have also been received from Bradford Washburn and C. W. Wright. In the process of being assembled and correlated are the numerous photographs and notes on the glaciers of southeastern Alaska that were taken in the summer of 1946 by Douglas Brown, Maynard Miller, and William Latady. The complete list of all those who have made contributions is too long to be given here.

In addition to the foregoing, the committee is indebted for many valuable photographs to the United States Geological Survey, the United States Coast and Geodetic Survey, and the International Boundary Survey. Instructive aerial photographs have been made available by the United States Navy, and plans are under way to acquire many of the aerial trimetrogon photographs taken by the Army Air Forces in 1941 and 1943.

It is hoped that those who have photographs and unpublished notes and manuscripts pertaining to glacier observations in Alaska will make such items available to the committee for inclusion in this collection.—François E. Matthes

SUMMER SCHOOL IN GEOGRAPHY ON THE VERMONT-QUEBEC BORDER. An interesting example of cooperation on the "Unguarded Boundary" is the summer school in geography to be held by McGill University at Stanstead College, in Stanstead, Quebec, near the Vermont border. A six-week course is planned, to begin July 1, and a program of lectures and field courses is being organized, "sufficiently comprehensive in scope to attract not only normal and high school teachers but graduates and members of the general public." The teaching personnel, of British and American geographers, will include, among others, Dr. L. Dudley Stamp and Professor Stanley D. Dodge. Particulars can be obtained from Professor George H. T. Kimble, Department of Geography, McGill University, Montreal.

SURVEY OF WAR WORK OF PROFESSIONAL GEOGRAPHERS. A report on the work done by American geographers during the war is being prepared by a committee of the Association of American Geographers for publication both in the *Annals* and in the *Geographical Review*. It will be appreciated if all who were employed as professional geographers in war work for the United States government will communicate as soon as possible with Dr. John B. Appleton, Division of Research for Far East, Department of State, War Annex No. 1, Washington 25, D. C.

The information desired includes name, present address, government agency with which associated, position held, and general nature of the work. It is important that every professional geographer so employed register in order that the survey may be complete.

OBITUARY

CLEMENT GILLMAN. The death of Clement Gillman in Tanganyika on October 5 ended the career of a pioneer in African affairs and a scientist of long and unvarying distinction.

From 1905, when Mr. Gillman went to Tanganyika as surveyor for a German railroad construction company, until his retirement as chief engineer of the Railway Department of the territorial government, his career was bound up with the Tanganyika railroad and with the wide-flung geographical ramifications that railroading can—and, in his capable hands, did—encompass. For example, when the spirit of expansion and consolidation of the empire fired the planners with enthusiasm to link the interior holdings by means of a north-south railroad, Gillman was dispatched on a journey of exploration to inspect the various routes southward that might lead to a possible junction with a line to be thrown up from the Rhodesias. His superb qualities of observation, analysis, and judgment, however, ended the hope of constructing the line on a paying basis and caused the project to be abandoned.

Perhaps the most important result of his long safari through southern Tanganyika was his recognition of the oasis character of the life of the East African native and the firm refutation of the widely assumed fallacy of "teeming millions in a land of plenty." Gillman's sharp eyes had discovered that because of the seasonality of the rainfall over much of Africa and the failure of the ground to hold enough water to last out the dry periods the population was crowded on about one-tenth of the land, where the water was adequate; that in those parts the soil was deteriorating and the water table steadily dropping; and that life in "the much overrated tropics" must in fact be viewed as precarious.

His long concern with the problem of water supply and his writings on the subject—for example, the comprehensive "Report on the Investigation of the Proper Control of Water

and the Re-organization of Water Boards in the Northern Province of Tanganyika Territory," published with E. O. Teale in 1935—led to his appointment as Water Consultant to the territorial government when that post was created in 1938, and his numerous publications include not only his reports on the water resources of the Territory but a wide range of studies in the physical and human geography, many of them published in British, German, and American scientific periodicals. Thus we have the constructive "Zum Inselbergproblem in Ostafrika" (1937), "Geography and the Civil Engineer" (1937), the delightful "Clouds and Cloudscapes" (1940), and "The East-African Peneplain" (1943). To the *Geographical Review* he contributed "A Population Map of Tanganyika Territory" (July, 1936) and "White Colonization in East Africa, With Special Regard to Tanganyika Territory" (October, 1942).

A subject of lifelong interest with Gillman was the great African mountain, Kilimanjaro. The massif grew to be an old friend, both from climbs and from incessant correspondence regarding it. "An Ascent of Kilimanjaro" (1923) was matched a score of years later by "A Bibliography of Kilimanjaro," and, if memory serves me accurately, he and his courageous wife visited the summit more than once, to share a bottle of champagne when the last weary step of the climb had been taken. "Gillman Point" stands today beside "Stella," "Hans Meyer," "Kaiser Wilhelm Spitze," and "Furtwängler" in the commemorative nomenclature of the crater summit.

Field work kept him on safari much of the time, but when at home his address was Dar es Salaam, on the shore of the Indian Ocean at 7° south latitude. There, in a library that surrounded him with thought-provoking materials, he succeeded in pushing aside the treacherous influences of climate and professional loneliness and maintained a rate of production that must stir the envy of his colleagues in the "energy-zones" of the temperate latitudes.

In a warm letter, dated November 20, 1945, Mr. Gillman illuminated once more his favorite subjects, and the active spirit of the man lives in these lines:

"We old ones are still going strong although—or is it because?—I have just celebrated the 40th anniversary of landing in Africa and my wife has only had 3 years less out here.

"We have made Dsm. our home since my retirement from Gvt. five years ago and I am pleasantly busy with my geographical problems and 100 and one tasks and interests. My 'magnum opus' for some time has been a vegetation map of T. T., long overdue, and after having devoted more than 1000 hours to it during the last 12 months it is now approaching a stage when it will soon, I hope, gladden the heart and reward the patience of Dr. Wrigley."

Gillman was above all else a confirmed and enthusiastic geographer in the best modern sense. His address on "The Place of Geography in Western Culture" delivered in 1945 before the Dar es Salaam Cultural Society (see *Records of the Dar es Salaam Cultural Society No. 3*), of which he was president for a number of years, is a classic essay on the content and importance of modern geographical science, its justification, and its duty "to guide human efforts into that direction which a careful analysis of the existing environment and an embracing synthesis of the present state of affairs might lead her to accept as the correct one, at least for the time being."—RICHARD U. LIGHT

LAWRENCE JOHNSTONE BURPEE. Dr. Lawrence Johnstone Burpee, eminent Canadian historian, geographer, and public servant, died at Oxford, England, on October

14, in his seventy-third year. He was on his way to the Continent to study the administration of relief in his capacity as president of the United Polish Relief Fund and honorary secretary-treasurer of the Canadian United Allied Relief Fund.

Dr. Burpee entered the Canadian Civil Service at the age of seventeen, and his long career of public service in many areas, his sponsorship of, and active participation in, numerous scientific, literary, and other cultural organizations, and his many books and articles on the history, geography, and exploration of Canada have made his name almost a household word in his country. Of his major published works, perhaps the best-known among geographers are "Pathfinders of the Great Plains: A Chronicle of La Vérendrye and His Sons" (1914), "Journals and Letters of Pierre Gaultier de Varennes de La Vérendrye and His Sons" (1927), "The Search for the Western Sea: The Story of the Exploration of North-Western America" (1908), and "The Discovery of Canada" (latest edition 1944).

Dr. Burpee was a founder of the Canadian Geographical Society, its first secretary, and the first editor of the *Canadian Geographical Journal*. His services to the Royal Society of Canada, in which he held many offices, including that of president in 1936–1937, and to the Canadian Historical Society were also conspicuous. From 1912 until his death he was Canadian secretary of the International Joint Commission established by treaty in 1909 with jurisdiction over all problems arising between Canada and the United States, and his long and meritorious service on this commission and his devotion to its principles have been recognized as an important factor in its excellent record.

GLACIAL MAP OF NORTH AMERICA. Compiled and edited by a committee of the Division of Geology and Geography, National Research Council, Washington, D. C. In 2 sheets, each 55 x 41 inches. Scale 1:4,555,000. Part 2, Bibliography and Explanatory Notes. By Richard Foster Flint. viii and 37 pp.; bibliogr. *Geol. Soc. of America Special Papers No. 60*. Geological Society of America, New York, 1945. $2.00.

For the preparation of this splendid map high commendation is due the Committee on Glacial Map of North America, appointed by the National Research Council in its Division of Geology and Geography and directed by Richard Foster Flint as chairman.

North America north of latitude 35° is represented on a Lambert conformal conic projection, with a maximum scale error of well below 6 per cent. The scale, approximately 72 miles to the inch, is ample for showing even relatively small features. Generalized contours, or form lines, indicate the configuration of the sea floor as well as of the land surface. On this base a well-selected color scheme shows "the areas believed to have been covered by the several glaciations," the areas of related lake and marine sediments and of outwash, and existing glaciers. Special symbols represent features such as striae, eskers, drumlin groups, and boulder trains. There are two small inset maps, one of the Northern Hemisphere showing existing glaciers and areas formerly covered by glaciers, the other of the central United States showing the distribution of the principal loess deposits. Footnotes giving additional information about specific localities are printed on the map, arranged by regions. The accompanying explanatory notes include an extensive bibliography.

Although the map summarizes with admirable clarity what is already known—or believed to be known—about the glacial phenomena of the continent, its greatest service may well be that it makes clear the need for further investigation of many problems. For example, the mapping of drift boundaries needs extension and refinement. Additional criteria are needed for age determination and correlation of drift where areal continuity of exposure is lacking, as in the case of the Jerseyan drift, which cannot yet be assigned satisfactorily even though it is mapped as a probable Kansan correlative. Intersecting sets of striae, a phenomenon so common in some regions as nearly to constitute the general rule, suggest a study of changes in direction of glacial movement. Possible causes are changes in the locus of greatest snowfall on the glacier and fluctuation in local rates of ablation and consequent changes in configuration of glacier margins.

The present edition of the map has wisely been limited. Some studies now in progress seem to promise significant new results that might be incorporated in a revised edition. And, of course, since the validity of field interpretations by individual geologists, from which the map has been compiled, cannot be readily checked in all cases, the results are understood to be subject to later correction if necessary.

Special mention should be made of the fact that this project was a cooperative enterprise to which scientists of both the United States and Canada contributed. Appropriately this review also is a dual effort; Dr. J. T. Wilson's comments that follow deal with the northern part of the map.—CHAUNCEY D. HOLMES

The Geological Society of America is to be congratulated on the publication of the "Glacial Map of North America," a compilation prepared by a committee of eminent glaciologists from material supplied by many organizations and collaborators.

Naturally enough, information is available in greatest detail along the southern border of the glaciated area, where overlapping deposits of many different stages present a complicated history. This is in striking contrast with the absence of indication of multiple glaciation along the Arctic margin of the ice sheet, but only further work can determine whether the contrast is real or is due to lack of information. In the Canadian Arctic islands, for instance, scarcely visible question marks on the map indicate that it is not even known whether all of them were glaciated or not.

In the vast area between these margins the latest glaciation destroyed evidence of its predecessors, but large areas of subsequent marine and lacustrine submergence are shown, and the scattered patches of detail emphasize how much can still be learned. The compilers have wisely avoided the question of ice centers and only indicate known striae, eskers, and moraines without attempting interpretation. The hypothesis of half a century ago that there were three centers of glaciation, in Labrador, Keewatin, and the Cordillera, has never been fully demonstrated or disproved. This map emphasizes the complexity of ice flow in the mountains and shows that in Keewatin, if the direction of a few striae were to be reversed, the remaining evidence could be interpreted to suggest a direction of ice flow from Hudson Bay rather than from any center in the Northwest Territories. In the field it is not easy to tell from striae alone from which of two opposite directions the ice moved, and in some reconnaissance geology the direction of movement has no doubt been deduced from current theories about ice centers rather than from clear field evidence. In such cases one could wish that striae were indicated by a symbol without an arrowhead. Similarly, for other areas in the north glacial information was derived from a study of air photographs without ground observations. In this case the direction of ice flow could be more suitably shown by the symbol for "groups of drumlins" than by that for "striae."

The map, by displaying prominently the regions still permanently ice-covered, emphasizes the importance of the Greenland icecap and suggests that further study of existing ice sheets will illuminate our theories on those that have wasted away. The need for more study is clearly shown by the surprising paucity of field observations recorded on the map—in all Greenland only nine in addition to the boundaries of the icecap and of the part of Peary Land mapped, in accordance with Koch's conclusions, as unglaciated. This interpretation of Koch's has been questioned by some authorities because the area includes mountain glaciers and obvious fiords and is so near the existing icecap.

As is the case in any compilation, some of the geological interpretations are doubtless debatable. Mechanical errors and imperfections, however, are few. Since so much recent topographical information has been included in the Northwest Territories, it is surprising that the air photographs used to provide glacial information were not also used to improve the topographical base for the District of Mackenzie. Some revision of the form lines of the Greenland icecap is necessary; for, besides minor errors in drafting and disagreement with contour intervals shown in the legend, the 8000-foot contour, according to Lindsay's survey of 1934 from Knud Rasmussen Land to Angmagssalik, should be about 30 miles closer to the coast. No doubt calling the Arctic Ocean a "Sea" was deliberate, but it is a borderline case; and since the popular tendency is to regard this body of water as narrower than it really is, it seems a pity to detract further from its significance by altering its established title.

The map is an outstanding contribution to North American glaciology. The clear distinction drawn between moraines, eskers, and marine and lacustrine deposits, consisting as they

do of different kinds of materials, will be of particular value to geographers, agriculturists, and civil engineers, to whom no single source of so much information of this kind has been available before. In the preparation of the map many differences of opinion on boundaries and correlations were settled. The use of separate colors for areas of undifferentiated age and the use of different symbols for boundary lines in accordance with the precision with which the boundaries have been established will stimulate new work and direct it to the places where it is most needed.—J. T. WILSON

MERRILLEANA: A Selection from the General Writings of ELMER DREW MERRILL. Pp. 127–394; maps, ills., bibliogrs. *Chronica Botanica*, Vol. 10, No. 3/4, 1946. Chronica Botanica Co., Waltham, Mass. (Stechert-Hafner, Inc., agent in New York City). $4.00. 10¼ x 6¾ inches.

In celebration of the seventieth birthday of Elmer Drew Merrill, Arnold professor of botany at Harvard University, *Chronica Botanica* has published this special double number.

During his long association with the Bureau of Science in Manila, Professor Merrill became the leading authority on the flora not only of the Philippine Islands but also of the Netherlands Indies, China, and Indochina. Many of his numerous publications (a complete bibliography is included) are concerned with the description and classification of the plants of these areas and with their distribution.

Although such works might at first seem to be of value chiefly to botanists, there is much in them to interest geographers. Professor Merrill goes beyond a mere description of the flora of a region, which in itself is necessary to the geographer, and explains the local variations in the nature and distribution of plants in terms of variations in climate, relief, and soil, and, in some cases, of man's activities. Man is "the most important single factor in the actual dissemination of plants" and "by far the most important and most destructive" of the factors affecting the vegetation of the world. In many parts of Malaya, for example, because of expansion of both native and plantation agriculture, "the pressure on the primary forest is rapidly increasing. . . The enormous trees and shade plants characteristic of the primary forest cannot persist under the conditions demanded by modern agriculture, and they cannot exist in the second growth forests, grass lands, and bamboo thickets that rapidly encroach on cleared areas that are abandoned. Perhaps without realizing the fact we are witnessing in our own generation the rapid extermination of some of the noblest types of tropical vegetation." The author therefore urges a rapid extension of botanical exploration in these areas and the establishment of forest reserves.

To his interest in the relations between the flora and the present environment Professor Merrill has in more recent years added an interest in the relations between plants and the environment of the past. In many cases, from the present distribution of plants we may logically infer the previous existence of land connections between areas now separated by water or, conversely, the absence of such connections. In the light of evidence of this kind Professor Merrill concludes, for example, that the hypothetical continents of Atlantis and Mu must definitely be "scuttled."

Professor Merrill, the "American Linnaeus," is known most widely for his taxonomic work and for his administrative activities in Manila (as director of the Bureau of Science) and in this country (as dean of the College of Agriculture at the University of California, director of the New York Botanical Garden, and administrator of botanical collections at

Harvard University and director of the Arnold Arboretum). From this collection of some of his more general writings it is clear that he has also the gift of grasping the broad general significance of his detailed botanical work and of interpreting it not only for other botanists but also for fellow scientists in such fields as geography and anthropology and for the general reader.

GEOLOGICAL INVESTIGATION OF THE ALLUVIAL VALLEY OF THE LOWER MISSISSIPPI RIVER. Conducted for the Mississippi River Commission, Vicksburg, Miss. By HAROLD N. FISK. vi and 78 pp.; maps, diagrs., ills., index; with accompanying portfolio of maps. United States War Department, Corps of Engineers, 1944. $6.00 (obtainable from the Mississippi River Commission). 12 x 9 inches.

Here are assembled a vast array of facts concerning the 600-mile-long alluvial valley of the Mississippi between Cape Girardeau, Mo., and the Gulf of Mexico. The data, drawn from the extensive files of the Mississippi River Commission and many other sources, are based mainly on the logs of 16,000 borings and complete air-photo coverage, supplemented by study of key localities in the field. The resources of the Mississippi River Commission have provided 80 figures and 33 magnificent plates, several of the latter six feet in total length and printed in colors. These maps and sections afford a three-dimensional picture of the alluvial valley never before attained.

The picture developed is that of a deeply intrenched valley system filled with sediments deposited by alluviation after the trenching. The floor of the trench, irregular because it consists of many individual channels, lies at depths ranging from 100 to 350 feet below present sea level. The trench has been filled with sediments gravelly in their basal part and grading irregularly up through sands into silts and clays. The fill is related to the streams that enter the alluvial valley, in such a way as to suggest large coalescent fans built by these streams. The internal character and the surface expression of these fanlike elements of the fill point to fully loaded, braiding streams. Even the streams that were not transporting glacial outwash are inferred to have possessed the braiding habit. The character of the higher and younger parts of the fill, which are finer-grained, indicates streams that were meandering rather than braiding.

In broad terms the author's interpretation of these features is that the intrenched valley system was cut during a time of glacially lowered sea level, whereas the fill was built up during later rise of sea level while glacier ice melted. Presumably the full loads of the braiding streams resulted from contributions of outwash by such streams as the Mississippi and the Ohio and from the rapid erosion of dissected earlier fills along the upstream courses of nonglacial rivers such as the Ouachita and the Red. This interpretation of the cutting and filling seems well founded in general, even though details may be questioned on the ground that stratigraphic contacts inferred from borings in unconsolidated sediments may not always be reliable. The author finds no evidence that stream discharges decreased progressively during alluviation. This is surprising; for although exaggerated concepts of the discharges of meltwater-swollen streams have been published, the proglacial Ohio and Mississippi Rivers would seem likely to have had greater discharges than they have now.

By projecting the seaward slope of the intrenched valley floor, the author infers a glacial-age sea level at least 400 feet lower than the present one. He suggests that the Mississippi entered the lowered Gulf near the head of the conspicuous submarine canyon that

has been identified in the continental slope. The sea level thus inferred is highly speculative in that the method by which it is determined cannot have great accuracy.

Because it appears to cut sediments believed to be upper Pleistocene, the intrenched valley system is dated by the author as "late Pleistocene" and is assigned an absolute age of 25,000 to 30,000 years. The inferred low sea level mentioned above is assigned to this date; this obliges the author to suggest that the volume of glacier ice may have been at its maximum in late Wisconsin [Mankato?] time, rather than in early Wisconsin [Iowan?] time, as is generally believed. This is not in accord with the facts of glacial geology and leaves the reader in doubt as to the validity of the correlation proposed by Fisk. It is further inferred from the sediments that the rising sea level reached essential stability about 5000 years ago.

The Mississippi River is described as a "newcomer" to the Gulf Embayment. The Missouri River and the Mississippi north of St. Louis are considered to have flowed northward to the Great Lakes–St. Lawrence region in preglacial time, and the Ohio flowed south via the Tennessee-Tombigbee route, reaching the Gulf near Mobile. This reconstruction is, of course, highly speculative. It disregards the abundant evidence on the preglacial Teays stream system of Ohio, Indiana, and Illinois, assembled during recent years, and to this reviewer it seems unlikely.

The earlier Pleistocene history of the alluvial valley does not fall within the scope of the report; hence, except for mention of terrace remnants of earlier fills, this subject is not dealt with. Aside from the improbability that the whole of the alluviation described falls within the last 30,000 years, it seems strange that remnants of earlier, pre-Wisconsin, alluvium should not remain in some parts of the intrenched valley system, beneath younger alluvium. One cannot help wondering whether some of the alluvial fill may not, in fact, be of pre-Wisconsin date.

These are matters that must be left for the future. The material presented in the present work is so well arranged that any reader not satisfied with some interpretation may refer to the maps and subsurface data and do his own interpreting.

Especially noteworthy is the reconstruction of successive systems of meanders made by the Mississippi and other large streams during the last few hundred years. The sequence of migrations and other shifts during this period, not only on the delta but also far up the valley, is reconstructed from air photographs and is beautifully represented in contrasting colors.

Geomorphologists, glacial geologists, and geographers will find many things to interest them in this impressive work, which is likely to be consulted as a basic reference for a long time to come.—RICHARD FOSTER FLINT

QUELQUES NOTES SUR LES COMMUNICATIONS DANS LES BALKANS: Principales lignes ferroviaires; ponts sur le Danube; issue à la mer Égée. By LUBIN BOCHKOFF. 47 pp.; maps, bibliogr. Académie Bulgare des Sciences et des Arts, Sofia 1945. 200 leva. 9½ x 6¼ inches.

In this little publication the former director-general of the Bulgarian State Railroads undertakes the task of discussing Balkan communications, with particular emphasis on postwar problems of reconstruction. His study reveals certain tendencies current in the Balkan region.

Mr. Bochkoff's main thesis is that Bulgaria, a great center of communications, should facilitate exchange between the northern Balkans and the U.S.S.R. on the one hand and the

shores of the Aegean on the other. (Throughout it is implied that access to the Aegean must be accorded Bulgaria before peace and prosperity can return to the Balkans.) Among changes and improvements discussed are the construction of bridges over the Danube between Belgrade and Cernavoda, a distance of more than five hundred miles where no permanent bridge has been built since Roman time; the building of new railroads across the Balkan Mountains and the Rhodope, to connect the Danubian plateau of northern Bulgaria with the Maritsa Valley and the Aegean coast; and the establishment of extensive port facilities at Porto Lagos and Alexandroúpolis (Dede Agatch) on the Aegean. The first of the Danube bridges should be constructed at Brza Palanka, in order to connect the Rumanian railroads with a future "magistral" linking the Danube with the Morava (at Niš), with Montenegro (at Podgorica), and with the Adriatic coast (at Bar). (The use of the term "magistral," current in Russian literature on overland communications, is worth noting.) Another Danube bridge should be built at Gigen, north of Pleven, thus establishing a link between Rumania and a future railroad line that would cross the Balkan Mountains from the Danube to the main west-east rail line of Bulgaria, which connects Sofia, Plovdiv, and Edirne. Finally, a third bridge should be built at Ruse, and direct communications established between Bucharest, Ruse, Stara Zagora, Momtchilovgrad in southern Bulgaria, and—another future line—Porto Lagos.

Mr. Bochkoff's study is amply documented with maps and statistical tables. Some of the tables, however, are regrettably obscure, and some of the maps, too, are confusing: it is rather hard to distinguish between facts and plans for the future. To be sure, certain of the errors may be due to negligence on the part of the draftsman, but they do raise doubts in the reader's mind. There is little question of Mr. Bochkoff's profound knowledge of his subject, and he has made an informative contribution on Balkan communications. It is the more regrettable, therefore, that his work should assume in places the tone and technique of a political pamphlet.—George Kiss

THE STORY OF INDIANA SOILS: With Descriptions of General Soil Regions and the Key to Indiana Soils. By T. M. Bushnell. 52 pp.; maps, diagrs., ills. *Purdue Univ. Agric. Exper. Sta. Special Circular 1*, 1944.

PEDOLOGY, "THE DIRT SCIENCE," AND AGRICULTURAL SETTLEMENT IN ONTARIO. By G. A. Hills. Map, diagr., ills. *Canadian Geogr. Journ.*, Vol. 29, 1944, pp. 106–127. (Reprinted and distributed by the Ontario Department of Lands and Forests.)

The day is past when geographers can avoid becoming reasonably competent on the subject of soil profiles. Fortunately, for reasons unknown to this reviewer, there has come a welcome increase in the ability of soil scientists to write down their organized data and interpretations so that any literate person can understand their findings. This is a great boon to geographers, most of whom are reasonably literate, but few of whom have been able to comprehend technical pedological jargon.

Bushnell's pamphlet is the culmination of many years of study of Indiana's soils. It is an extremely effective presentation, for farmers, geographers, and other folk who are not specialists in soils, of a complicated set of phenomena and their relations to land use. A careful reader can learn a great deal about the soils of adjacent states as well, since Nature has

little respect for straight-line state boundaries. Such a reader will also learn much of the broader significance of soil relationships not commonly recognized. For example, "no man has the right to destroy soil even if he does own it in fee simple"—a devastating comment on the English-derived law, as applied to land, under which we have suffered for so long in most parts of the United States and Canada. Or again, "if you want to know something about the soil, ask the soil," a painful dose to swallow for not a few "adjustment-philosophy" geographers; for there are some of this variety who would not look at any physical feature until they were certain it was significant in "an adjustment of man" to it. "A man usually sees what he is looking for" summarizes the incredible story of man's not seeing much about soil profiles, and therefore not discovering, until recent decades, their significance to crops and native vegetation.

The pamphlet might well be used as a text for training geographers in soils. Its advantages for this purpose are numerous; not the least is the fact that nothing superfluous for a geographer is included. The university department starting its students on soils need not be located in the Middle West to employ such an introduction advantageously, though of course the closer the institution is to Indiana, the more pointed in significant local applications the study will be. Indiana possesses a wide range of soils: several hundred types fall into gray-brown podsolics, prairie soils, planosols, wiesenbodens, and alluvial soils. And here it should be noted that the author introduces unfamiliar technical terms with a skill that makes acquisition almost painless.

The manual possesses unity, coherence, and emphasis to a degree equaled by few pieces of writing read by the reviewer in a long life devoted to reading. Aerial photographs are skillfully employed, and the maps and diagrams are excellent. Bushnell has used a procedure in preparing this publication that geographers all too seldom follow—the preparation of maps and the selection of photographs *before* the text is written to interpret and elaborate what the graphical materials so well display. The tabular "Key to Indiana Soils" condenses and presents clearly a mass of related facts about several hundred soil profiles. The "catena" relationship of soil profiles, one of the most valuable of all soil concepts to geographers, is emphasized and gives reason to local areal distribution of soils. Appropriate land uses of the various Indiana soils are fully and effectively treated.

Hills's article on Ontario soils is another masterpiece of simple, effective, scientific presentation of a complicated subject. Excellent aerial photographs of wisely selected landscapes and good photographs of characteristic soil profiles with lengthy notes thereon elaborate on the map that is the basis of the text. The map itself, on a scale of about 1 : 11,500,000, emphasizes areal relationships of larger soil categories and is the best of its kind this reviewer has seen.

Aside from the specific information on soils and their utilization in Indiana and Ontario that these two publications offer, their value to geographers in three respects may well be stressed: (1) explanatory phrases, tied to various localities on the maps and to particular spots in the photographs, make both maps and photographs much more valuable than is commonly the case and thereby reduce the necessary text; (2) a comparative study of the two works reveals effectively different ways of treating a relatively small area such as Indiana in greater detail and a much larger area such as Ontario in less detail; this involves significantly different soil categories; (3) for geographers who have not known enough about either soils

or agronomy to handle with assurance the broader relations between soils and crops, these examples of what to do in regional studies, on two different scales, are most helpful.

Both studies have been made possible only by years of closely associated investigations by numerous soil scientists. Few jobs done by American geographers, until the stress of war forced them to work together, are as far removed from the "lone wolf" method of research as these two fine publications on soils.

This reviewer is not an expert on soils. The most he would claim to be is an interested amateur—this in spite of the fact that his tutors in the field through the past 25 years have included Marbut, Lapham, Shaw, Veatch, Schoenmann, Kellogg, soils men in the Soil Conservation Service too numerous to mention, Thorp, Williams, and Gieseker (the last three during the summer of 1946 in the Bitter Root Valley of western Montana). He hereby pays tribute to them all, along with Bushnell and Hills, for a much-appreciated education. Such publications as those reviewed here supplement but do not take the place of field association with pedologists.—WELLINGTON D. JONES

ROCHESTER, THE WATER-POWER CITY, 1812–1854. By BLAKE MCKELVEY. xvi and 383 pp.; maps, ills., index. (Rochester Public Library, Kate Gleason Fund Publs., 1.) Harvard University Press, Cambridge, Mass., 1945. $4.00. 9¼ x 6 inches.

This is a straightforward account of the formative years of Rochester, N. Y., "America's first boom town." After a brief exposition of the environmental setting, the author describes the ambitious land purchases out of which, in the 1790's, came the Pulteney Estate. In providing for its settlement, company agents selected various townsites, but Sodus Bay and the lower Genesee area did not hold first place in their plans: the Susquehanna, not the Mohawk, was then viewed as "the proper gateway to the Genesee Country." Interior towns such as Bath and Williamsburg received greater attention; moreover, fears of unhealthfulness and Indian attack, and the prohibition by Upper Canada of American shipping on Lake Ontario, conspired to delay a permanent settlement on the lower Genesee. By 1812, however, the stage was set for the growth of Rochesterville. The bridgehead became a mill town and later a lake port, but "the modest development anticipated by the local optimists of 1820 fell far short of that which actually occurred when the Erie Canal channelled the increasing flood of westward migrants through Rochester." A new appreciation of "Clinton's Ditch" as an artery of trade and migration results from a reading of this scholarly and interesting treatise.

Many personalities move through these pages; for, as the author says in his foreword, "the role of the individual was much more important in the Water-Power City than in its industrial and institutionalized successor." Biographical data are, however, kept well in hand, being introduced as they illuminate a particular feature of time and place. For example, it is shown that Rochester's promoters, Southern in origin, devised a town pattern without a commons, a somewhat anomalous feature among upstate New York's communities. Most of Rochester's early residents, as distinct from the promoters, came from the northeastern seaboard.

With this new work carrying forward Helen Cowan's recent analysis of the Genesee Country (Charles Williamson: Genesee Promoter, Friend of Anglo-American Rapprochement, *The Rochester Hist. Soc. Publs.*, Vol. 19, 1941), west-central New York takes rank in the list of well-studied American regions.—RALPH H. BROWN

WORLD RUBBER AND ITS REGULATION. By K. E. Knorr. x and 265 pp.; map, diagrs., bibliogr., index. *Food Research Inst. Commodity Policy Studies No. 6,* Stanford University, Calif., 1945. $3.00. 9¼ x 6 inches.

This volume is a mine of information on the history, uses, economics, and statistics of an essential raw material that is of vital importance to every citizen of this country. A short introduction outlines the importance of the commodity, the problems involved, and the plan of treatment. Then follow chapters on supply between the wars, trade and uses, and economic characteristics of the rubber market. The historical development of the industry is traced, from wild rubber to cultivated plantation. The author shows how the introduction of bud grafting from high-yielding strains (clones) in the late 1920's increased the production several times over that of ordinary seedlings and thus not only increased the future potential production of individual trees but also greatly reduced the production costs of estates that planted or replanted areas with budded rubber. The areas planted to budded rubber are still relatively small compared with the total acreage, but the proportion was steadily increasing in 1940 and will undoubtedly continue to increase. It is also shown that the crop from rubber trees differs essentially from other tree crops; for example, in the time required for the tree to come into profitable production and in the continuous, instead of periodic or seasonal, production. Most of the work is done by hand, and in the major producing countries, except Java, labor has to be imported. In times of rising prices production cannot be expanded quickly, and, conversely, it is not quickly curtailed.

Nearly half the book is devoted to the discussion of subjects that mostly affect our own interests: the international control of the supply of crude rubber, and the recently developed synthetic rubbers. In recent times two artificial controls of production have been put into effect. The so-called "Stevenson scheme" was instituted by the British, acting alone, in the early 1920's. The plan proved cumbersome and inflexible in operation and slow in regulating releases of exports to conform to market conditions, and by not allowing exports to build up stocks in consuming countries it resulted, by 1925, in exorbitant prices. One important result was an enormous increase in planting and production in nonparticipating countries; prices finally fell, and in 1928 the scheme was abandoned. The newly planted areas caused production to increase further and prices to fall still lower, and in 1934 an international agreement was entered into by the governments of Great Britain, the Netherlands, France, India, and Siam. This scheme proved more flexible than the previous one and, on the whole, more successful. However, Dr. Knorr's conclusion is that these artificial control measures were wrong in principle: the proper balance between supply and demand could have been achieved by a reorganization of the plantation industry.

The creation of the gigantic synthetic-rubber industry in this country in the war years has completely changed the production picture and for the first time has made the rubber supply independent of the virtual monopoly heretofore held by Great Britain and the Netherlands. This raises grave problems for the future economy of the rubber-growing areas, both for the native populations and for investors in the plantations. For some purposes synthetic rubber is superior to the natural product and vice versa, but it is agreed that with present knowledge and technique a certain percentage of natural rubber will always be required. It is assumed that in the future the costs of synthetic rubber will be competitive with those of natural rubber, and competition both in prices and in uses will determine which will furnish the larger part of the world's supply. Thus arises the question of how

much of our present synthetic facilities should be retained. Taking everything into consideration, Dr. Knorr estimates that the United States will always keep in operation at least sufficient plant capacity to meet our military needs and for special uses; this he places at one-fourth of the capacity erected during the war.

Regarding national defense, he discusses briefly the question of advisability of protection of domestic sources (guayule) and near-by sources in Latin America and concludes, rightly, that Latin-American sources cannot compete in the postwar market without some form of subsidy. This would seem to involve good faith and good neighborliness as well as economics, since our government has encouraged those countries to embark on rubber planting, though admittedly on a small scale, with the implied understanding that a market would always be available for their product; without some form of subsidy this would not be possible.

To solve the problem of future surplus capacity, an effort may again be made to form some kind of international regulation; in that event the consuming countries, predominantly the United States, will have the determining role.—O. D. HARGIS

BUILDING THE FUTURE CITY. Edited by ROBERT B. MITCHELL. Pp. vii-viii and 1–162; maps, diagrs., ill., bibliogrs. *Annals Amer. Acad. of Polit. and Soc. Sci.*, Vol. 242, November, 1945.

The literature of city planning is both abundant and diverse. Every age and every nation has been faced with the problem of building compact settlements in such ways as to satisfy contemporary needs. The city-planning movement is as old as antiquity; but it is also as modern as tomorrow, because in a changing world no generation can rely on plans constructed by former generations to deal with conditions of life that have since become at least partly obsolete. Changing social needs call for new concepts in city planning.

It is not surprising, then, that periods of rapid social change (and destruction) such as World War II should be marked by the introduction of a wide variety of new ideas into the philosophy of city planning. In America, we have at last come to realize that urban living and the urban way of life have become predominant in the American social scene. Philosophers, historians, and analysts in nearly every other field of human knowledge have given attention to these developments and applied the knowledge and techniques of their own field to them. City planners must now embrace the findings and recommendations not only of architects and engineers but of sociologists, geographers, economists, political scientists, public-health and recreation experts, and numerous others if their designs for the future are to incorporate our knowledge of the present. It is fitting, therefore, that The American Academy of Political and Social Science should devote an issue of its *Annals* to city building, in a symposium that represents the current thought of scholars in many fields. Of particular interest to the geography profession is the inclusion of a liberal sample of current geographic thought, presented by Chauncy D. Harris, Edward L. Ullman, and Otis W. Freeman.

The contribution of geography to the planning of cities has been of fundamental significance. In general, it has focused attention on function and structure. By repeated and painstaking analysis the geographer has shown that cities have individuality and that no city may be understood except in relation to the site it occupies and the territory it serves. Detailed studies of settlements in all parts of the world and with a great variety of cultural and physical

environments have provided him with a superb factual background for constructing generalizations concerning city development and for testing generalizations advanced by students in other fields.

Harris and Ullman present the most comprehensive analysis of the theory of urban geography that has yet appeared. In "The Nature of Cities" (pp. 7-17) they follow a brief statement of the functions of cities with an analysis of the spacing of cities in accordance with the functions they perform. Functions and spacing are closely associated with structure. Here the authors present three theories designed to explain differences in occupance within the city: the concentric-zone theory, the sector theory, and the theory of multiple nuclei. Far from being mutually exclusive, these theories represent progressive stages toward a more realistic approach to the analysis of the structure of cities. Harmonizing them promises to go far toward bridging the gap that has long existed between social theory and planning. One feels that Harris and Ullman have pioneered an important undertaking.

In "Natural Resources and Urban Development" (pp. 30-45) Freeman is concerned particularly with the city as a product of the area it serves. Systematically, he examines the urbanizing influences inherent in the utilization of mineral, agricultural, forest, water, and fishery resources. Numerous American examples are given, and the author cites a large number of local studies by American geographers.

These articles provide an excellent background for the great variety of approaches to urban problems that fill the remainder of the volume. The geographer should find all of them worthy of study; but he will be particularly impressed with the contributions that geography is making to city planning and with the rapid strides that are being taken in the field of urban geography.—H. H. McCarty

VUE GÉNÉRALE DE LA MÉDITERRANÉE. By André Siegfried. 191 pp.; maps, diagr. N.R.F.-Gallimard, [Paris], 1943. 59 frs. 9 x 5½ inches.

André Siegfried, professor of political and economic geography at the Collège de France and one of the best known of French political scientists, has for some time been expanding his interests, formerly focused on the English-speaking democracies, to the Latin world. In the 1930's he published a small but delightful volume on Latin America and an important work on Suez and Panama. For several years he taught courses on the political geography of the Mediterranean. In this latest book he attempts an over-all study of the general features of the region.

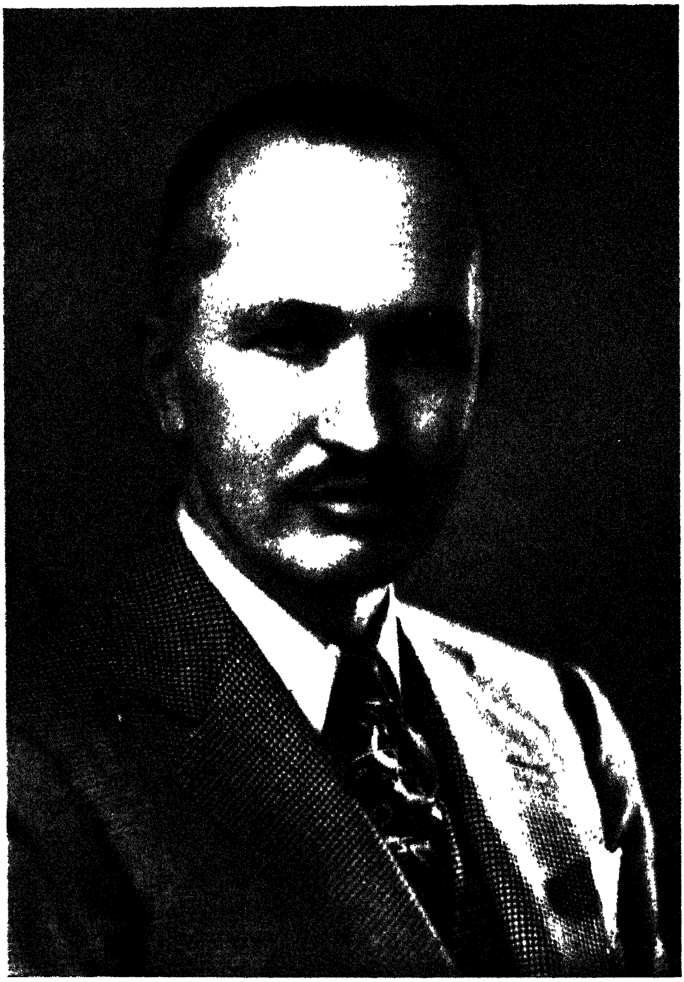
It is not an easy task to sum up in a small volume the vast knowledge of, and the passionate interest in, the Mediterranean world. Mr. Siegfried applies to the problem his inimitable skill for keen and subtle analysis, but he does not succeed in giving to this book the breadth and depth that characterize his earlier works. Published under Nazi censorship, his "Mediterranean" cautiously avoids all the political problems and issues that make the region crucial in world affairs. The author often quotes the best authorities on Mediterranean geography, but only their most classic writings, and one regrets that he derived so much inspiration from such works as Paul Morand's "L'homme pressé."

Nevertheless, this general view of the Mediterranean is well worth careful reading and thought. In every chapter the author endeavors to define and stress some characteristic of Mediterranean nature, way of life, or economy. He skillfully balances the underlying unity that prevails over the region and the innumerable variations of the gradual transition from

Atlantic Europe down to the desert. Throughout, the main emphasis is on the "economic civilization": in this aspect Mr. Siegfried sees in the Mediterranean civilization the antithesis of the American. He sees the Mediterranean cultivating the Greek tradition of "individualism and ingenuity, of patience and frugality" that America has deserted. He believes we should still consider characteristic of the Mediterranean a small-scale, nonmechanized agriculture and a local, closed life. However, he does not ignore the fact that the Californian type of farming, based on crop specialization, mechanization, and world-wide marketing, flourishes in many corners of the Mediterranean; he devotes a whole chapter, "the industrialization of the cultures," to this side of the regional economy. He stresses in the same way the duality of Mediterranean industries: the persistence of the craftsman side by side with the modern plant. The cradle of Western civilization assimilates a great many Americanisms with ease and promptness.

In defining the place of the Mediterranean in the world Mr. Siegfried calls it the "land of articulation" (*pays de l'articulation*). The definition betters the old notion of "link" and "transition," but it would have gone still further if cognizance had been taken of Jules Sion's work on the rural civilization of the Mediterranean (published posthumously in the *Bulletin de la Société Languedocienne de Géographie*, 1940), in which the region is defined as "the land of the discontinuous (*du discontinu*) in space as in time." Not all parts of the Mediterranean are transitional, and not all are links. Few parts of the world are, in fact, as rich in striking contrasts. Finally, the "articulation" would have been plainer if Mr. Siegfried had not attempted too narrow a delimitation of the truly Mediterranean lands: he generally applies this term strictly to the European peninsulas and islands of the classical sea. Thus he loses sight of some of the main elements: the Levant and the desert's fringe, Islam and the nomads and such old centers of Mediterranean civilization as Egypt, Mesopotamia, Palestine, and Byzantium. Perhaps Athens and Rome were always the purest jewels, but "Mediterranean civilization" was never a clear-cut crystal. Most of Mr. Siegfried's sources are limited to European aspects of the region, but it is hard to cover the geography of the Mediterranean when such authors as E. F. Gautier and Henri Pirenne are neglected.

Nevertheless, Mr. Siegfried's "Mediterranean" condenses a wealth of facts and ideas and constitutes a considerable improvement over the small number of general works on this part of the world. Any geographer may read it with pleasure and profit. Few scholars possess Mr. Siegfried's ability to give elegant form to an amorphous scientific mass.—JEAN GOTTMANN



RICHARD UPJOHN LIGHT

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RICHARD UPJOHN LIGHT

PRESIDENT OF THE AMERICAN GEOGRAPHICAL SOCIETY*

IT IS both an honor and a pleasure to announce that on February 7, 1947, the Council unanimously elected Dr. Richard Upjohn Light as President of the American Geographical Society.

The Society is to be congratulated in having as its leader for the coming years a man of such diverse talents and attainments. Dr. Light has the rare distinction of having achieved success in two different fields. He is both an eminent surgeon and a geographer. After graduating from Yale University and Michigan Medical School, he studied under Dr. Harvey Cushing at Boston and subsequently taught surgery at Yale University and later at the University of Rochester. Since 1936 he has practiced neurological surgery in Kalamazoo, Michigan, where he was born.

For many years Dr. Light has been interested in aviation, and he has long found recreation in exploring strange lands by long-distance flying. He is a qualified pilot and flies his own plane. In 1930 he flew to Panama and back, in 1932 to Mexico; and in 1934 and 1935 he circled the globe by air, except for the Pacific, which he crossed by ship. These flights kindled a serious interest in geography and brought Dr. Light in contact with the Society.

He spent much time at the Society in preparation for a flight in 1937 and 1938, which took him and his wife through Central and South America and the whole length of Africa. After his return he wrote "Focus on Africa," which was published by the Society in 1941. Its literary style, its sound and discerning scholarship, and its magnificent illustrations, reproduced from photographs taken by Mrs. Light, have made this volume a geographical classic and led to Dr. Light's election to the Council of the Society in the same year. Dr. Light still continues to divide his interest between medical

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* For a report on the meeting of the Society at which Dr. Light's election was announced, see below, pp. 312–313.

and geographical matters, and he is responsible for having initiated the Society's project for an Atlas of Diseases that we believe will demonstrate the far-reaching contribution modern geography can make to medical science.

It has been my privilege to serve as President of the Society since 1934. During these thirteen years the harmonious collaboration between Council and staff and the vitally important part that the Society was able to play during the war have contributed to the steady advancement of geographical science and the place that the Society occupies in national affairs. It is with regret that I relinquish the presidency because of other duties, but I am confident that in Dr. Light the Council has chosen a leader whose energy, broad vision, and personality will still further enhance the reputation of the Society.

Dr. Light becomes the eleventh President of the American Geographical Society. With the exception of Admiral Peary, who served from 1903 to 1907, he is the only President who has not been a resident of New York. For many years the Society has been an international institution in its membership and in the scope of its scientific interest and influence. In recognition of this broader orientation, the Council has chosen as President a resident of another part of the country. This step is appropriately taken at a time when the United States must assume an even more important role in international affairs. I am confident that under Dr. Light's leadership the work of the Society will be carried to higher goals of public and scientific service.

ROLAND L. REDMOND

THE AGRICULTURAL REGIONS OF GUATEMALA

E. C. HIGBEE

ACCORDING to averaged planimeter readings made on the American Geographical Society's Millionth Map of Hispanic America the area of Guatemala is 109,122 square kilometers. Although this area is comparable with that of Tennessee, the agricultural regions of the country probably exhibit as much crop diversity as can be found in the whole United States. Changes in altitude and, thus, in temperature are the prime determinants of crop provinces in Guatemala, and rainfall variations exert decisive influence within altitudinal belts. The contour lines approximately defining the critical high and low temperature limits for important crops are convenient to use in separating regions. All such lines are, of course, arbitrary, since transition zones between the regions are wider than the lines indicate.[1]

Petén and Caribbean Lowlands

Most of the Petén and Caribbean Lowlands region lies between sea level and the 500-meter contour. Only the Poptún plateau, the Montaña del Mico, and the Montañas del Gallinero, along the Honduras border, rise above the upper limit, and, although physiographically distinct, they do not depart from the general land-use pattern of the region. With the exception of about 2000 hectares of abacá and 5400 hectares of bananas in the lower Motagua Valley belonging to the United Fruit Company and affiliated producers, this vast area of some 5,000,000 hectares, more than 46 per cent of Guatemala, is practically undeveloped.

Scarcely 3 per cent of the country's approximately 3,500,000 inhabitants live in this region, and most of these are concentrated in the lower Motagua Valley. The entire department of Petén has fewer than 12,000 people. Curiously, between the second and sixth centuries of the Christian Era the civilization of the Old Mayan Empire developed and flourished in this part of present-day Guatemala, whereas other parts of the country, with the possible exception of the Pacific coast, remained relatively less important

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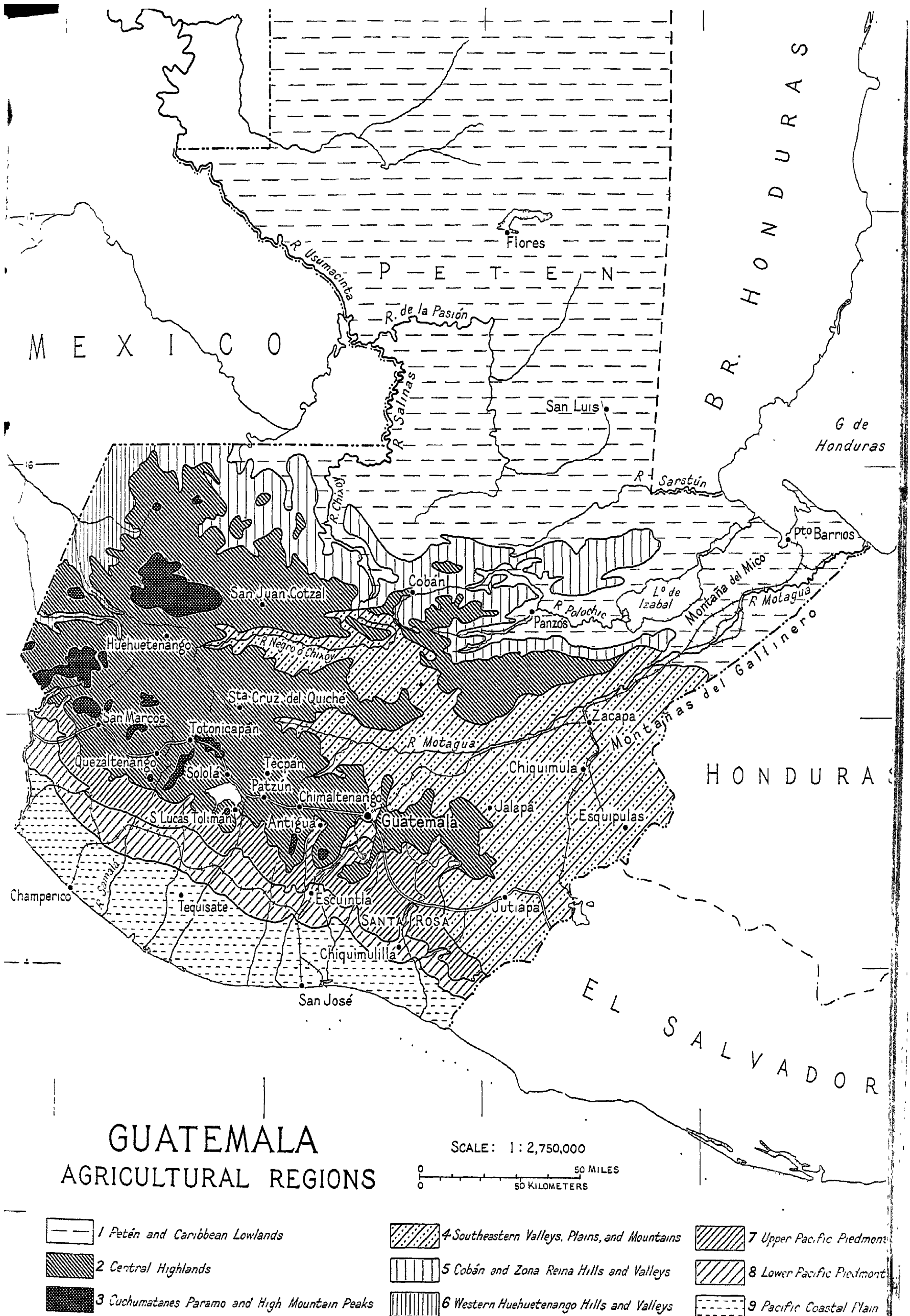
[1] The accompanying map of the agricultural regions of Guatemala could hardly have been prepared without the aid of the American Geographical Society's Millionth Map of Hispanic America, which was used as a base. I should like to express my appreciation for the planimeter readings, obtained through the kindness of Mr. Charles B. Hitchcock, and also for the many helpful suggestions offered by my colleagues at the Instituto Agropecuario Nacional. For the aerial photographs thanks are due to James Mitchell, Office of Foreign Agricultural Relations, U. S. Department of Agriculture

until a later date. Perhaps it will always be a matter of conjecture why the Mayas achieved here the critical transition from a migratory to a peaceful agricultural society. Speculation on the causes of that flowering are, however, by no means idle in view of the popular attitude in Guatemala that the region is undesirable for farming and the fact that measures taken by the government to persuade farmers to colonize it have so far met with indifference, though the soils would support expanded settlement. Perhaps the prevalence of malaria is the chief deterrent; for except in the Fruit Company villages no effective measures have yet been taken to combat the mosquito vector or to cure the infected human hosts of the disease. It is hardly conceivable that malaria or any equally serious tropical disease was present in this region at the time the Mayas were developing their civilization.

Except for the Motagua Valley banana lands and the savannas around Libertad, the region is almost completely forested today, as it very likely was before the early Mayas began to concentrate on agriculture. This introduces another puzzling element into the question why the Mayas became farmers instead of remaining wandering hunters, fishermen, and small-scale gardeners. Primitive people with implements of wood and stone seem to have been less inclined to develop agriculturally in forest areas than in deserts or semiarid regions where river water could easily be diverted for irrigation and where land clearing was comparatively simple or even unnecessary.

Exclusive of bananas and abacá, the principal market commodities obtained from this extensive area are chicle gum and mahogany logs—both forest products. The banana industry is primarily a development of the United Fruit Company, which, by using the techniques of modern agricultural and sanitary engineering, has made its properties both healthful and productive. Certain areas of the Polochic, Pasión, and Usumacinta river valleys could produce equally fine bananas, but local capital displays no interest in developing them.

Transportation facilities in the region are notably inadequate except for two single-track, 3-foot-gauge railroads. Traversing the lower Motagua Valley is the northeastern section of Guatemala's cross-country line. The other railroad, about fifty kilometers long, follows the lower Polochic Valley, obtaining most of its revenue by hauling coffee to the river port of Panzós from the mountainside plantations of the Cobán region. Although the department of Petén is crisscrossed by an immense web of footpaths and mule trails over which the chicle gatherers travel to and from their forest gum camps, there is not even a cart road to link it with central Guate-



GEOGR REVIEW, APR. 1947

FIG. 1—Agricultural regions of Guatemala. For Tequisate in the Pacific Coastal Plain read Tiquisate. Areas of the regions and percentages of total area: Region 1 50,277 sq. km., 46.0%; Region 2 20,072 sq. km., 18.4%; Region 3 1,423 sq. km., 1.3%; Region 4 14,904 sq. km., 7.3%; Region 5 6,200 sq. km., 5.7%; Region 6 1,583 sq. km., 1.4%; Region 7 4,217 sq. km., 2.3%; Region 8 3,715 sq. km., 3.4%; Region 9 6,731 sq. km., 6.2%.

mala. The people of the region fail to produce enough food to support themselves; hence imports must be brought in by airplane, river boat, and pack mule from other parts of Guatemala and from abroad.

The Central Highlands

Most of Guatemala's population live by subsistence agriculture, and the greatest concentration of its small-scale hoe and machete farmers is found in the Central Highlands region, popularly termed the *tierra fría* or "cold land."[2] Most of them are Indian descendants of the tribes that lived on the same soil before the days of the Spanish conquest. In no other country will one find so many Indians who have been able to retain continuous possession of their lands as well as certain corrupted semblances of their ancient culture. The survival of this large landed Indian population is one of the characteristic aspects of present-day Guatemala.[3] Perhaps because there are few extensive areas of productive land in the Central Highlands, the Indian has been left relatively unmolested by the more aggressive and influential whites and mixed-bloods, who, during the past four hundred years, have acquired most of the really choice lands of Guatemala in the Pacific piedmont and coastal plain.

The Central Highlands region, lying between the 1500- and 3000-meter contours, occupies about 18 per cent of Guatemala and can boast of two redeeming features. It is favored with a cool, invigorating climate, and the dreaded malaria is seldom contracted there. Most of the Indian population have preferred a meager existence in the tierra fría to becoming pioneer settlers in Petén or resident laborers, *rancheros,* on the great commercial coffee, sugar, and livestock estates on the Pacific coast.

Thousands of Indian families in the Central Highlands find it impossible to grow enough corn, beans, wheat, and potatoes to feed themselves on their small submarginal holdings, which ordinarily are not large enough either to support them or to offer full-time employment. About three arable hectares is the minimum necessary for independent family existence on average tierra fría land, where corn and wheat annually yield about 25 bushels a hectare. Each year, in spite of their reluctance to leave the cool climate of the highlands, these indigent families, most of whom own less than three hectares of land, migrate to do seasonal taskwork—to pick the

[2] Although certain geographers have defined this region as *tierra templada,* Guatemalans include it in the *tierra fría.*

[3] See also G. M. McBride and M. A. McBride: Highland Guatemala and Its Maya Communities, *Geogr. Rev.,* Vol. 32, 1942, pp. 252–268.

coffee, cut the sugar cane, and plant the range grasses on estate lands to the south. Since farm machinery is almost as much of a curiosity on the large farms of Guatemala as on the small ones, this supply of cheap Indian labor from the tierra fría is highly important economically. Without these seasonal laborers, known as *cuadrilleros*, the present commercial agricultural economy of the country would collapse.

Most of the tierra fría consists of rocky, untillable mountainsides studded with pine and oak and gashed by steep, eroded *barrancas* or ravines. The average cultivated land, eroded and impoverished, lies on the crests and gentler slopes of worn-down, rolling hills. The finest parts of the Central Highlands are restricted intermountain valley plains and river terraces. The Samalá Valley and its tributaries, extending from Totonicapán through San Cristóbal and on to the west of Quezaltenango, comprise the largest and choicest of the good sections of the tierra fría. Ranking second are the several intermountain plains of deep soils derived from volcanic material grouped around and within the Chimaltenango-Tecpán-Patzún triangle. Important but limited areas are found in the vicinity of the department capitals of Huehuetenango, San Marcos, Santa Cruz del Quiché, and Sololá. There comparatively good soils are sufficiently extensive to support concentrated settlement.

Nearly the whole region suffers from a dry season of five to six months between December and June, but fortunately at the higher altitudes heavy mists and dews often make the soil moist enough to germinate seed and support the early stages of plant growth long before the rainy season itself begins. This condition permits the cultivation of corn nearly to the summer frost line, where as much as eight or nine months may be required for a crop to mature. Each 300-meter increase in altitude may add three or four weeks to the growing season of this principal crop. The Central Highlands produce more of Guatemala's annual average of 27 million bushels of corn than any other region. During the past two years the price of corn, which is raised almost exclusively for direct human consumption, has fluctuated between two and five cents a pound. At the same time the average daily wage of farm labor has varied between 20 and 30 cents a day plus a standard ration of one to two pounds of corn. The average Indian workingman eats two pounds of corn daily in the form of *tortillas, tamales,* and *atole* (gruel). By weight, corn constitutes about 75 to 85 per cent of his diet; the remainder consists of beans, sugar, chili peppers, coffee, salt, a few garden vegetables, wild herbs, and occasionally a little meat. Those who raise wheat sell most of it to flour millers in order to buy corn. Most wheat products are eaten by

FIG. 2—Sololá near the shores of Lake Atitlán. Central Highlands.

FIG 3

FIG. 4

FIG. 3—Planting corn at Los Encuentros near Sololá. Central Highlands.

FIG. 4—Shepherd boy standing by his grass shelter near Los Encuentros. Central Highlands.

FIG. 5—Between Sololá and Totonicapán. Central Highlands.

FIG. 6

FIG. 7

FIG. 6—A Chichicastenango Indian preparing a piece of sterile hillside soil for corn planting by using a pick. Central Highlands.

FIG. 7—A wheat farmer near Sololá. Central Highlands.

white and mixed-blood, *ladino,* city dwellers. Wheat cultivation begins usually at about 1800 meters and may be found as high as 3000 meters. Coffee and sugar cane as commercial crops seldom appear in this region.

A traveler in the Central Highlands will not fail to note that in spite of the unproductive soil and his own poverty the Indian apparently has little desire to live according to the white man's sense of values. The average Indian male shows a characteristic unconcern about tomorrow and a decided lack of industry; however, when impelled by necessity, he works with incredible endurance at the most fatiguing tasks. As a matter of fact, he does not have enough land to keep himself fully occupied, and the rewards of working for others are scarcely of the kind to inspire ambition. His satisfaction with a crude diet, an overcrowded, uncomfortable house, and an untidy yard coupled with his love of leisure and a traditional addiction to *fiestas* and self-performed religious ceremony is matched only by the lack of effort and interest on the part of whites and ladinos to set an elevating example or to offer him genuine inducements to come out of his lethargy. The cleavage between Indian and white remains broad and deep.

Cuchumatanes Paramo and High Mountain Peaks

The decisive influence of altitude on plant and human life becomes strikingly evident in the mountaintop areas of Guatemala above 3000 meters. Except for potatoes, this altitude marks, as closely as a single figure can, the upper limit of field-crop cultivation. Potatoes seem to grow reasonably well at the low temperatures prevailing as high as 3200 meters. The upper limit for practical corn cultivation seems to be 2900 meters, though frost damage may occur at somewhat lower altitudes. The ability of some native Guatemalan corns to develop normally at low temperatures should be of interest to breeders who would like to improve the cold resistance of northern Corn Belt strains.

Some potato patches are found on the upper slopes of the volcanic peaks along the Pacific coast, but the upper slopes of recently active volcanoes are barren. Forests occupy most of the land, broken by occasional stretches of alpine meadow. Of all the scattered high-altitude areas, the Cuchumatanes Paramo of Huehuetenango and Quiché is the most important agriculturally. Because of the low rainfall, it is primarily a series of bleak savannas, grasslands that afford excellent sheep pasture except during the driest months of January to May. Crisscrossing the grasslands are rocky ridges sparsely studded with cypress, pine, and the little stone-fenced fields of potato-raising, potato-eating Indians.

The Cuchumatanes Paramo is almost as extensive as all the other scattered mountain peaks together. About one-third of it is occupied by the 24,000-hectare Hacienda Chancól. On the hacienda are more than 40,000 head of sheep belonging to some 500 Indian families who purchase pasturage rights at two cents an animal a month and sell their semiannual wool clips to the hacienda. Nowhere else in the country is sheepherding carried on as intensively as in this area, which bears little resemblance to any other part of Guatemala but which may be compared with the Andean paramos of Peru and Ecuador. The sheep roam the unfenced expanses in little flocks shepherded usually by women and children, who are so unaccustomed to strangers that they tremble apprehensively when spoken to, if they do not actually run away, chasing their sheep ahead of them. Nearly all the Indian shepherd families rent land on the rocky, cypress-studded ridge slopes rising usually less than 100 meters above the savannas. There they build adobe, grass-thatched houses and grow potatoes. Houses and potato yards are customarily enclosed with stone walls built to protect the crop from wandering sheep; sometimes the walls of neighboring plots run end to end for a kilometer or more and offer a common barrier to the flocks. Many of the Indians also rent wheat and corn lands at lower altitudes in order to produce a supplementary grain supply.

The wool clips average about a kilo a head two times a year; the local price in the spring of 1946 was about 66 cents a kilo. At such rates a family with a hundred head of sheep may attain an annual gross cash income from wool sales of approximately $132, which the cost of pasturage rights will reduce by about $24. For potato land a common rental fee is some seven dollars a hectare. Yields on unmanured lands average 2½ tons a hectare, but few families plant as much as that. Nearly all the potatoes are consumed by the growers' families. As in the Andes, it is the general practice on the Cuchumatanes Paramo to corral the sheep at night in demountable paddocks, which are moved every two or three weeks over pieces of fallowed ground. The top-dressings of manure that result from this system double and even quadruple the yields of potatoes subsequently planted on the ground where the sheep have been corralled.

At night trained dogs guard the sheep against coyotes, and usually some member of the family sleeps in a grass shelter near the corral in case of trouble. Nights on the paramo are bitterly cold, and the days are never hot, though the sun's rays will burn the skin more intensively than in the lowlands. The people wear wool wraps or *ponchos* except during the middle of the day, and a long fleeced sheepskin is the common bed mat.

FIG. 8—Valley of Antigua; approximately the upper limit for commercial sugar cane and coffee production. Upper Pacific Piedmont.

FIG. 9—Chiclero and subsistence farmer standing in his field of taro at Carmelita, Petén. Petén and Caribbean Lowland.

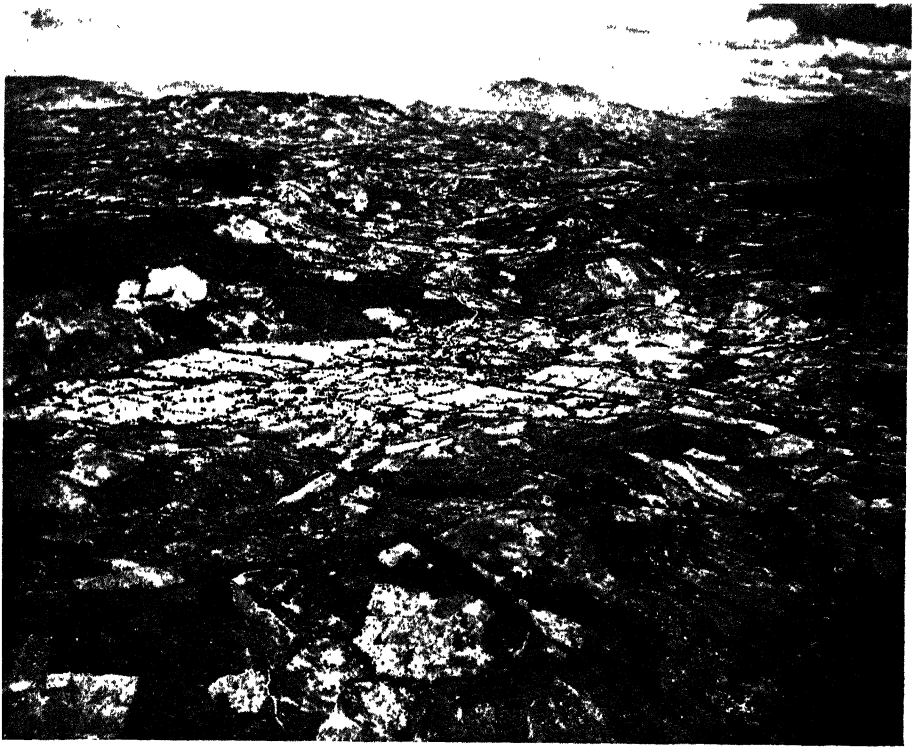


FIG. 10—Near San Pedro Pinula. Southeastern Valleys, Plains and Mountains Region.

FIG. 11—Threshing rice near Jutiapa. Southeastern Valleys, Plains, and Mountains Region.

Southeastern Valleys, Plains, and Mountains

The Southeastern Valleys, Plains, and Mountains region lies below the 1500-meter contour, above which are the Central Highlands. The two regions are indistinguishable at the arbitrary boundary line, but above and below it the regional differences rapidly become pronounced. Guatemala City, which lies astride the continental divide at 1500 meters, offers a good point of departure from which to make field observations of these peculiarities. The lowest altitudinal limits of the region are reached in the middle Motagua Valley, which grades downward from 500 to 100 meters above sea level, and along the Pacific coast, where the 500-meter contour line defines it. In the middle Río Chixoy Valley it shades into the Cobán and Zona Reina region as the influence of heavier rainfall begins to appear. Similar transition belts divide it from the Upper Pacific Piedmont in the departments of Santa Rosa and Jutiapa and south of Guatemala City.

This region is as diverse in its physiographic features as the Central Highlands; for it, too, is dissected by numerous streams and cut by deep ravines, crisscrossed by mountain chains and dotted with lakes and extinct, eroded volcanic cones. The choicest farmlands lie on river terraces, on the inclined, gullied plains skirting mountain foothills such as that on which Guatemala City is located, and on lake shores where the soils are deep and relatively productive. Most of the region, being unfit for permanent cultivation, has been abandoned to cutover scrub brush and grass range. Good woodlands are few except at the higher altitudes. Some of the most productive areas are irrigated, and further irrigation developments are a possibility. Malaria is endemic in the region, but it has not become as serious a menace to public health as it is in the lowland regions of Petén and the Pacific coast.

Although the climate, in comparison with that of the Central Highlands, is somewhat enervating at lower altitudes, this unfavorable feature is compensated by the relative ease with which the subsistence farmers can gain a livelihood. In a sense this is the most desirable region in Guatemala for subsistence farming, since population pressure on arable land has not reached the extremity evident in the Central Highlands. Not only are most of the people independent landholders but their farms are usually large enough to provide them a livelihood without the necessity of seasonal employment as cuadrilleros. The dry, temperate to warm climate permits the growing of numerous tropical fruits such as mangoes, sapotes, bananas, and citrus fruits. Since most of these are consumed locally, good quality is considered secondary to ease of cultivation, and little effort is made to raise superior products.

The oranges of Rabinal are a notable exception; they are considered by many housewives to be the best in the country.

Corn and beans for direct consumption are the principal crops, but the region is also noted for its rather low-grade tobacco, upland rice, and garden vegetables, particularly tomatoes, chili peppers, and various cucurbits. Grain sorghums replace corn to some extent in numerous localities, particularly in the very dry middle Motagua Valley and in low-altitude areas bordering El Salvador and Honduras.

Through this region thousands of emaciated cattle from the ranges of western and central Honduras travel to the lush guinea-grass pastures of Guatemala's Pacific Coastal Plain and Lower Piedmont regions for fattening and eventual slaughter. Most of these cattle cross the border near Esquipulas and head for Escuintla by the general route of Jutiapa and Chiquimulilla. At Escuintla they are bought by owners of the coastal ranges, who send them on to their properties. Most of the large landholdings in this region are also devoted to cattle raising, but, as with the imported Honduran cattle, many of the animals must be sent to the Pacific coast for fattening because of the dearth of good grass, particularly during the long dry season from November to May, when even the drought-resistant jaragua grass (*Hyperrhenia rufa*) turns brown.

The inhabitants of the region are principally ladinos, though there are many fullblood Indians who still practice their own religious rites and have retained some semblance of tribal organization.

The Cobán and Zona Reina Hills and Valleys

This region, lying to the north of the Central Highlands, is bounded by the same altitudinal limits (500- and 1500-meter contours) as the Southeastern Valleys, Plains, and Mountains region, but its climate is distinctly humid between May and December. In some parts the weather is seldom dry except in March and April. In altitude and climate the region is comparable with the Upper Pacific Piedmont, but land resources are markedly inferior. The topography is a hill and valley complex, and the soils, derived principally from sedimentary rocks, are generally shallow and unproductive as compared with those overlying the deep volcanic deposits on the Pacific coast. The best soils of the Cobán and Zona Reina region are in the depressions and on the gentle lower slopes of the hills.

Although such commercial crops as cardamom, henequen, and sugar cane are grown, coffee far outranks them all. Yields are generally lower, and production difficulties greater, than those on the Pacific Piedmont.

From two to three times as many man-days of labor are required to place a hundred pounds of green coffee beans at a transportation center as in that more favored region, where the man-day average is 12 to 18 per hundred pounds. Much of the increased cost is due to the lack of highways, which obliges plantation owners or *finqueros* to transport their crops by pack mule over long distances. Because good soils are limited and are generally found in isolated swales, the coffee groves on a single plantation are sometimes widely separated. Overhead expenditures also exceed those of the Pacific coast; consequently, if it were not for the lower daily wages of the local plantation laborers, which amount to about ten cents for a normal daily task, the growers could not afford to remain in business. I once asked a prominent local businessman why he thought so highly of a region that to me appeared generally submarginal for commercial agriculture. "Not the soil but rather the low wages of our laborers are the wealth of the Cobán," he replied. "Without them we could not exist." This region contributes between 6 and 9 per cent of Guatemala's annual coffee production.

On the other hand, the Cobán and Zona Reina region is not as poor a place for subsistence agriculture as the Central Highlands. Population pressure is not so great, and second-class land is fairly plentiful. Most of the Indians live as rancheros, or resident laborers, on large estates, where they are provided without charge with all this type of land they wish to cultivate. Yields of 25 to 50 bushels of corn to a hectare are ordinarily obtained by practicing a rotation of corn for a year or two followed by volunteer bush for three to five years and then back to corn. In the Cobán, or eastern section of the region, much of the land available for corn cultivation has been cut over and has the shaved-off appearance characteristic of all cutover areas where a genuine forest is not given time to restore itself. The low bush is easy to cut, and the burning, if well done, not only adds a top-dressing of fertilizing ash to the soil but retards weed growth long enough for the first corn crop to become established. Machete or hoe weeding of the *milpas* or cornfields is often omitted in the first season after the burn. Most of the corn is consumed directly by the growers' families. Beans, green vegetables, fruits, chickens, and pigs also are raised, and these, together with salt and coffee rations obtained from plantation owners, make the Indians practically self-sufficient in food. Sugar is about the only common article they do not provide for themselves, so that on the whole they are better fed than the Indians of the Central Highlands; but money, as their wages indicate, is a minor factor in their economy.

The Zona Reina, or western section of the region, is popularly regarded as the undeveloped El Dorado of Guatemala. To date, however, its real or illusory riches have not stimulated the construction of a single highway within its territory, although one does extend to San Juan Cotzal. Roughly 800 hectares are planted to coffee in the Zona Reina, as compared with some 16,000 hectares in the Cobán, but yields are reported to be higher because of more favorable soils.

Western Huehuetenango Hills and Valleys

Although there is a scattering of coffee *fincas* in this region, which occupies most of western Huehuetenango, the cultivated land is chiefly devoted to corn grown by subsistence-farming Indians. The rough and dissected topography, comparable with that of other mountainous areas in the country, seriously restricts the amount of good tillable soils but offers extensive if poor grazing lands. A number of municipalities have large tracts of public wasteland where the Indians may freely pasture their cattle and sheep. Occasional flood terraces along the riverbanks afford small patches of rich alluvial soil, sometimes less than an acre in area, intensively cultivated in preference to steep hillsides that can be cropped for only a few years at a time without being retired to bush and grass. The steepest hillsides are a mosaic of planted and abandoned fields.

This is the least accessible of all the mountainous regions in Guatemala. It is without airplane landing fields or highways; all traffic is borne by pack animals or porters. It has, however, an excellent postal service maintained by Indian foot couriers, who carry the mail and parcel post on their backs over the mountain trails rapidly, safely, and according to fixed schedules, as did the legendary runners of the Old Mayan Empire. The region is comparable with the Central Highlands, being densely populated and having corn as the major crop; but as it lies at a lower altitude, fair yields of sugar cane, bananas, platanos, yuca, and citrus fruits can be obtained on the better soils.

Many of the Indian farmers prefer to live in villages rather than in isolation on their own lands. Some have a head or two of scrub or *criollo* cattle, which the women take turns in herding. Every morning the cattle are collected in a house-to-house roundup and driven to the hills to graze; at night they are returned to the villages and redistributed to their owners. The better cows may give two or three quarts of milk once a day; those with surviving calves have no surplus for their owners' consumption. The stable manure is saved and carried to the cultivated fields.

Fig. 12—A cinchona plantation surrounded by coffee groves. Upper Pacific Piedmont.

Fig. 13—Drying coffee in the sun at Chocolá. Upper Pacific Piedmont.

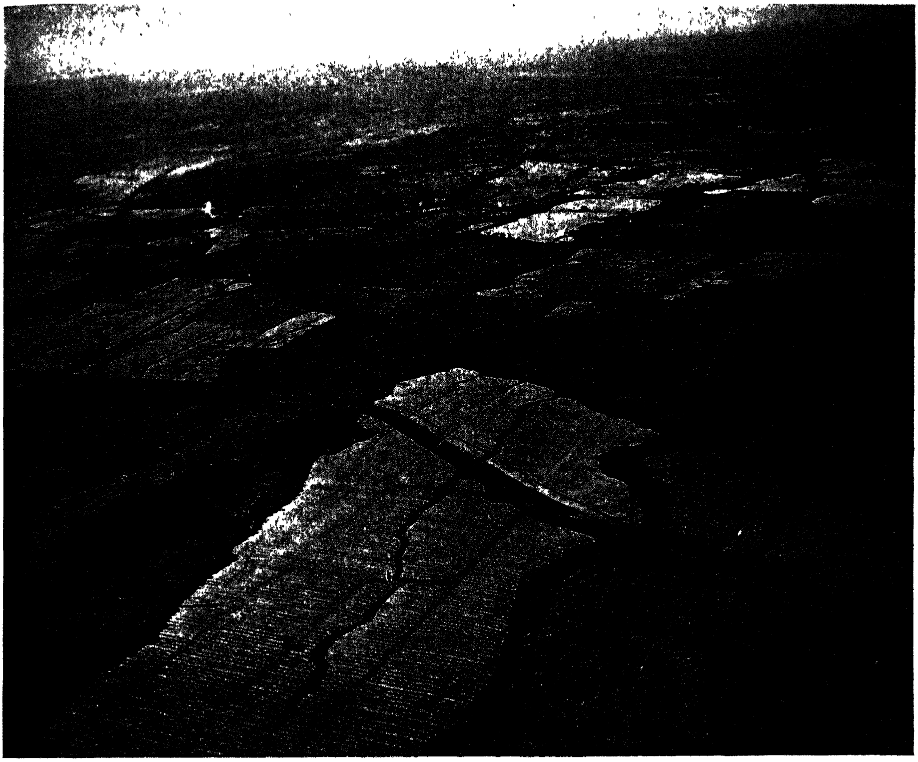


FIG. 14—Sugar cane plantations and grazing lands. Lower Pacific Piedmont.

FIG. 15—Coffee Pickers. Upper Pacific Piedmont.

The Upper Pacific Piedmont

This region, lying between the 500- and 1500-meter contours and extending along the Pacific coast from Mexico nearly to El Salvador, contains some of the most productive land in Guatemala. Although the Central Highlands support more of the population than any other region, they do so only because of the miserably low standard of living. In comparison, the coffee estates on the Upper Pacific Piedmont not only support tens of thousands of Indian rancheros in a comparable primitive condition and offer temporary employment to tens of thousands of highland cuadrilleros at picking time but also supply most of the surplus wealth that keeps foreign and domestic commerce alive. The national government itself is provided with that important percentage of its revenue which is derived from coffee export taxes and from the operation of its own extensive plantations, which make it by far the largest coffee producer in the country. Income from its coffee fincas defrays about 15 per cent of the national budget.

The soils of this region, matched only by those of the Lower Pacific Piedmont and, to some extent, by those of the Pacific Coastal Plain, are among the finest in the American tropics. They are derived from deep accumulations of volcanic material and are friable and highly productive in spite of the leaching action of a heavy rainfall, which averages between three and four meters in the western two-thirds of the region. Most of the land is erodible, steep, and cut by numerous rivers and gullies, but the coffee plants and the trees shading the coffee groves afford better protection against serious soil erosion than any annual clean-tilled crop would afford. Yields average between 1200 and 1500 pounds of dried green coffee, *oro,* to a hectare, though some plantations reach a production of more than 2500 pounds. As the frontier of El Salvador is approached in eastern Santa Rosa and southern Jutiapa, the mountains of the coastal cordillera become lower and rainfall decreases considerably, making moisture conditions less favorable for coffee.

Near San Lucas Tolimán, on the shore of Lake Atitlán, and also around Antigua, there are districts slightly above the 1500-meter contour, by which the upper limit of this region is generally defined. However, these two sheltered areas are included, since they produce some of the country's finest coffee. Ordinarily the cold weather and occasional frost damage above the 1500-meter line make coffee culture impractical, and the excessive heat below 500 meters is considered detrimental to quality.

Without coffee the whole picture of Guatemala's economy would be different. The amenities that wealth and commerce provide could not exist

without it, yet coffee in Guatemala, like cotton in the United States, is beset by a plague of economic ills. Under the most efficient management, 12 to 18 man-days may be required to produce a hundred pounds of high-grade Pacific-coast dried green coffee, which has a present f.o.b. value of about $25 a hundred pounds. From five to seven dollars of this amount is paid to common labor. Since the world's demand for its cup of coffee depends in considerable measure on the price, and since little can apparently be done to mechanize coffee cultivation and harvest, the countries that depend on this crop for a substantial part of their national wealth must do so at the sacrifice of progress and decent living standards for a large part of their populations.

It is a popular notion that so-called "agricultural countries" are necessarily reduced to a low standard of living, whereas, perhaps, it may be the inefficiency of the agricultural system itself that is in fault. This may be true particularly if the best land is held in partial idleness through failure to convert earnings into capital improvements or if the best land is planted to low-value export crops because success with more remunerative crops would require investment in research and more conscientious supervision on the part of plantation owners. While excellent land resources are neglected in these ways by government and private estates, a sizable part of the rural population may be obliged to waste its energy in inefficient subsistence agriculture on inadequate areas of submarginal land. This is the case in Guatemala. The condition there may eventually change, but the change will probably require decades. The most progressive finqueros in the Upper Pacific Piedmont region are planting cinchona, which promises to be more remunerative than coffee. Considering the world's need of quinine for the treatment of malaria, this crop is out of the depressing surplus bracket. More than 400 hectares are planted to cinchona in Guatemala, and the country is now exporting both alkaloids and crude bark.

The Lower Pacific Piedmont

The Lower Pacific Piedmont, extending along the Pacific coast from Mexico to El Salvador, is another of the more important agricultural regions of Guatemala. Within this long, narrow belt, lying between the 100- and 500-meter contours, most of the country's sugar cane is grown, and it is also a large producer of corn, rice, cotton, cacao, bananas, and low-altitude coffee. Many of the finest cattle ranches, *haciendas,* as they are known in Guatemala, are in this region. The soils not only equal those of the Upper Pacific Piedmont, but the gentler slopes make them suitable for intensive mechanical cultivation.

FIG. 16—United Fruit Company banana plantation at Tiquisate. Pacific Costal Plain.

FIG. 17

FIG. 18

FIG. 17—Banana cutter at Tiquisate. Pacific Coastal Plain
FIG. 18—Sugar cane cutter. Finca Palo Gordo. Lower Pacific Piedmont.

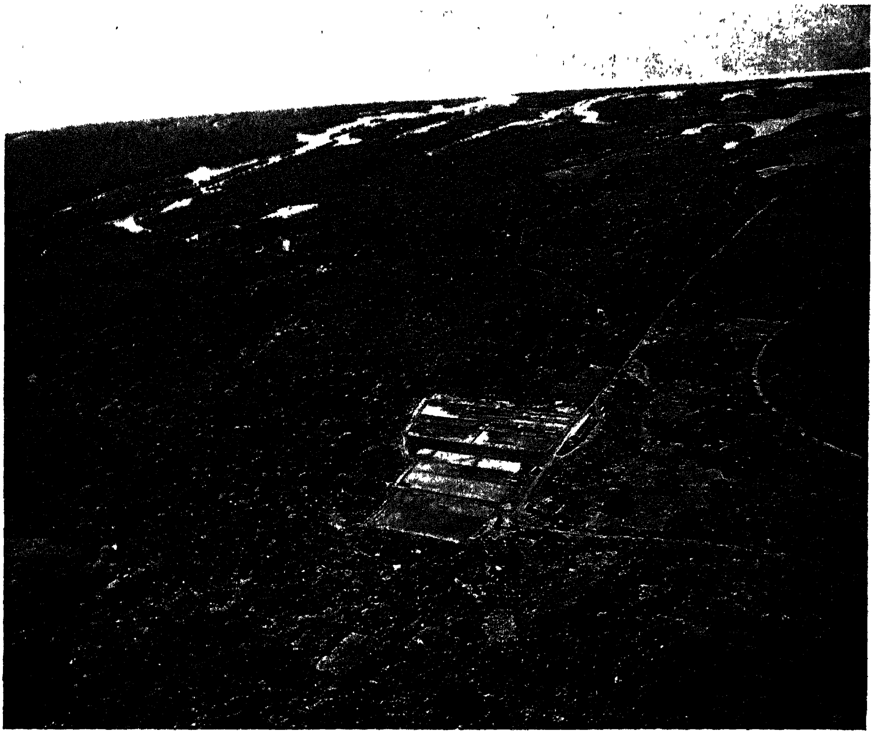


FIG. 19—In the center foreground a series of asphalt patios where salt is obtained by solar evaporation of sea-water. Pacific Coastal Plain.

FIG. 20 FIG. 21

FIG. 20—Peeling cinchona bark. Upper Pacific Piedmont.
FIG. 21—Woman and child near Retalhuleu. Lower Pacific Piedmont.

In few parts of the American tropics has Nature been so kind to plants while remaining indifferent to man. Favored by a warm climate and a rainy season lasting from May to December, two crops of corn, each averaging between 25 and 70 bushels to a hectare, can be grown in succession on a single piece of land each year. By the use of better seed and cultural practices, including the application of sufficient manures, insecticides, and commercial fertilizers, these yields could probably be doubled. In some low spots, where drainage is poor in the rainy season, a crop of corn can be raised in the dry season because of the high ground-water table. Year after year, without the application of fertilizers, the annual yields of sugar cane average between 30 and 70 tons to a hectare, an amount equivalent to three to seven tons of refined sugar. Coffee grows along the northern rim of this region between the 300- and 500-meter contours, and tropical flowers, for which Guatemala is justly famous, give a luxuriant beauty to the landscape. In contrast with the vigor of the vegetation, man's debility appears the more striking. Malaria, malnutrition, intestinal parasites, and anemia have done their work with crippling effectiveness.

Extensive stretches of virgin land are left in idleness, and many cleared areas have gone back to brush because man has not been able to keep pace with Nature. The introduction of sanitary services to safeguard public health coupled with the mechanization of many farm operations would greatly improve the efficiency of rural labor, which still accomplishes nearly all the tasks of cultivation and harvest with hand, hoe, and machete. Only exceptional haciendas and fincas attempt to control malaria effectively on a community scale, yet each estate has its own community of peons, ranging from a few families to several hundred. The large sugar-cane fincas have made the greatest strides toward modernization, though they are still largely dependent on oxen to pull their plows, cultivators, and carts. A definite postwar trend toward mechanization already in progress in this region is a promising sign.

One hundred hectares of guinea grass will carry an average of 100 to 150 head of cattle through the year, and the stock will multiply 100 per cent in three to five years despite a high calf mortality. Even in view of the high carrying capacity of first-class guinea-grass ranges, only small extensions are cleared from forest and planted each year, and old ranges are rarely plowed and replanted, though they are customarily burned over every few years to retard the encroachment of second-growth forest.

A rotation of bush-crop-bush prevails on cultivated areas not converted to range or to sugar cane or some other perennial crop, in spite of superior

soils that could stand a more intensive agriculture. Some land is rented on a cash or share-crop basis to highland Indians who migrate to the coast in the rainy season to grow corn and beans. Since two crops a season are possible, some Indians plant cotton, to sell for cash, after the early corn has been harvested. Although cotton is native to Guatemala, the country produces less than one-quarter of its textile-mill requirements. In return for

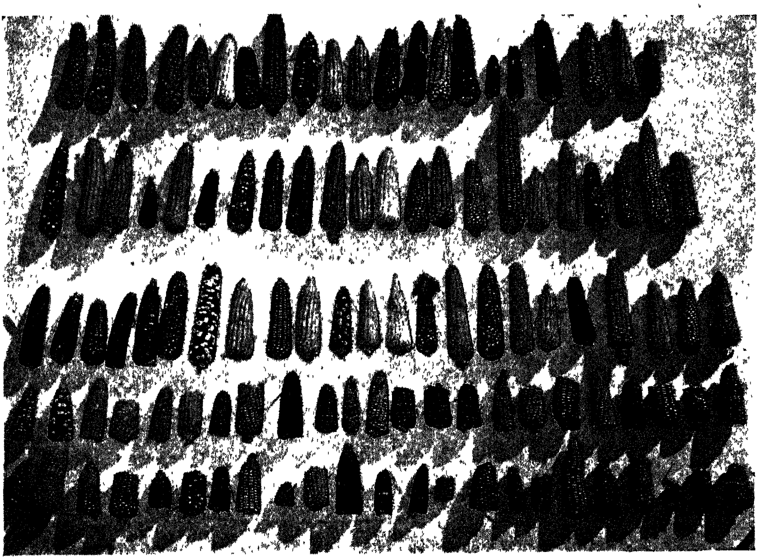


FIG. 22—A collection of some Guatemalan corns made by staff members of the Agronomy Division of the Instituto Agropecuario Nacional.

the use of land, Indian renters may plant perennial guinea-grass clumps in between their hills of corn; consequently, at the end of the season a new piece of range will have been started. Indians may also work off a season's rent by clearing forest from the piece of land used. Gradually the forests, already selectively logged of their best commercial timber, are being converted to ranges under a combination of these arrangements, but progress is slow. The most intensive land development in this region has taken place parallel to the railroad that traverses the western section between Mexico and Escuintla.

The principal agricultural taxes are levied on crops rather than on land, with the result that the most active operators pay the heaviest assessments. A reversal of this policy, which would exempt crops but tax land, might exert sufficient pressure to develop idle but potentially productive soils. As it is, much land lies idle or little used from generation to generation because the enormous size of some of the estates enables them to return

satisfactory incomes despite their low level of exploitation. Inefficient expenditure in the past of public moneys derived from crop taxes and earmarked for roads and sanitary services has developed strong opposition to increased taxation of lands, since it is the general opinion of farm operators that neither adequate roads nor sanitation services would be provided even though the funds were collected for those purposes.

In my own opinion this region of Guatemala has the most promising future. Someday, many decades from now, it will be the garden spot of Central America, but modern farm machinery, agronomic research, roads, and effective public-health services will all be necessary to bring this about.

The Pacific Coastal Plain

The almost level lands of the Pacific Coastal Plain form Guatemala's southern border and extend from the seashore to the 100-meter contour—a belt nearly 150 miles long and from 10 to 25 miles wide. The region is still relatively undeveloped, but large areas of good soils lie beneath its forests. The northern section together with the adjoining Lower Pacific Piedmont is potentially the most productive part of the entire country. However, near the seashore the rainy season of four to five months is inadequate for such commercial crops as bananas and sugar cane and for good range without irrigation, even though the total precipitation may be more than 40 inches. Quick-maturing subsistence crops such as corn, beans, and rice can be grown under optimum conditions. This part of Guatemala is known for its *ganado cimarrón,* or so-called "wild cattle." The average forest and brush range is so poor that it is considered uneconomical to divide the estates into fenced sections for rotational grazing, and most properties are bounded by a single fence inside which the herds rove at will until they are rounded up for branding, castrating, or sale.

Precipitation gradually increases toward the Lower Piedmont. Equally important is the fact that the rainy season may be prolonged from April to November in favorable years. It is in this northern half of the belt, bordering on the Lower Pacific Piedmont, where the annual precipitation ranges from 60 to 80 inches, that prospects for future development are most promising. Here is one of the most unusual agricultural enterprises in Guatemala, the 8700-hectare Tiquisate banana plantation of the United Fruit Company and associated independent growers. Superior living quarters for its employees and efficient measures taken to combat malaria and other tropical diseases have made it a desirable place in which to live and work despite the warm climate. To counteract the effect of the low rainfall and the annual

dry season, the Fruit Company's plantation has been completely equipped with an overhead irrigation system.

The mixed hardwood and palm forests of the Pacific Coastal Plain remain largely uncut, though much desirable commercial timber has been logged from all but inaccessible areas. The aerial panorama of this region presents a vast patchwork of cutover forests, open swamps, brushlands, and clearings, with the forests predominating. Swamps, most numerous near the coast, are scattered through the full length of the plain. Some of them are seasonal, drying out sufficiently between rainy periods for forests to become established; others either are covered with hydrophytic grasses and sedges or are open, stagnant pools rimmed with aquatic vegetation. In between the swamps lie large areas of well-drained lands, far more satisfactory for subsistence farming than the soils of the tierra fría. Conditions unfavorable for health and the fact that most of the lands, even though idle, are held in large private and government estates have prevented the highland Indians from colonizing them. Bird life, including egrets and ducks, characterizes the swampy areas, which are noted as hunting grounds for local sportsmen.

THE DISTRIBUTION OF INDIANS AND INDIAN LANGUAGES IN PERU

JOHN HOWLAND ROWE

THE publication of the first volume of reports on the Peruvian census of 1940 has put at the disposal of geographers and anthropologists a vast amount of material bearing directly on problems that have been argued for the last thirty years.[1] The tables now available summarize only certain aspects of the returns, but enough information is given to suggest some interesting conclusions. It is the purpose of the present article to analyze the census figures referring to the distribution of Indians and Indian languages, and to arrange them in contemporary and historical perspective.

The maps, Figures 1 to 4, illustrate the analysis. Figure 1 is a key to the other maps, showing the division of Peru into departments and provinces and into the geographical zones of coast, highlands, and eastern forests according to "Censo 1940 I," Figure 4. The eastern-forest zone is a frontier; part of it is inhabited only by "wild" Indians living in tribal organization, part by persons living under Peruvian law and protected by Peruvian military posts. As this division is important for interpreting Figures 2 to 4, the settled areas have been approximately indicated by shading, based on R. B. Hall's population-distribution map, "Censo 1940 I," Figure 2. Figure 7 in "Censo 1940 I," giving the density of population by provinces, will also be found useful for any study of population problems. Figures 2 to 4 accompanying this article give the percentages of "Indians" and speakers of Indian languages in the total counted population by provinces. They are based respectively on columns A to C of Table I.

It might be well to point out here some of the principal sources of distortion on such distribution maps as Figures 2 to 4 or "Censo 1940 I," Figure 7. In the first place, Peruvian provinces are not always comparable units. They differ immensely in size and population, and many of them contain areas uninhabited because of mountains or desert. Several of them include parts of different geographical zones, where the populations may be very different in quantity or quality. Urbanization also distorts the picture.

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[1] República del Perú, Censo Nacional de Población y Ocupación, 1940, Vol. 1, Resúmenes generales, Ministerio de Hacienda y Comercio, Dirección Nacional de Estadística, Lima, 1944 (referred to hereinafter as "Censo 1940 I"). See also Alberto Arca Parró: Census of Peru, 1940, *Geogr. Rev.*, Vol. 32, 1942, pp. 1–20; and Dr. Arca Parro's report on "Estado de la instrucción en el Perú según el Censo Nacional de 1940," Ministerio de Hacienda, Departamento de Censos [Lima, 1942].

The spelling of the place names in the text and table of this article follows that of the American Geographical Society's "Civil Divisions Base Map of the Americas 1 : 5,000,000," 1944.

No distinction is made in the parts of the census with which we are concerned between urban and rural populations, though these often differ most widely in "race" and language. Two provinces, Callao and Cusco, are so small as to include little beyond the cities for which they are named. In Lima and Arequipa the urban population is so much larger than the rural that percentage figures for the provinces represent the urban portion only, though the provinces contain large rural areas. Other towns large enough to influence the provincial figures are Mollendo, Huánuco, Ica, Pisco, Huancayo, Trujillo, Chiclayo, Iquitos, Moyobamba, Tacna, and Tumbes. Cajamarca, Ayacucho, Abancay, Andahuailas, Sicuani, and Puno lie in provinces where the rural population is so large as to mask any effect of urbanization (Censo 1940 I, Table 4).

The Census

This census was the first complete census taken in Peru since 1876, and the first modern one ever taken in that country. It reflects great credit on the director, Dr. Alberto Arca Parró, and his fellow workers. The count was made on June 9, 1940, and forms were filled out for a total of 6,207,967 persons. This is the *población nominalmente censada* to which most of the tables refer. The Census Commission calculated that some 465,144 persons had not been counted in the settled parts of the country, and the scattered Indians of the eastern forests, who were also not counted, were estimated at 350,000. The total population of Peru was therefore set at 7,023,111, of whom some 88.5 per cent were actually counted.[2]

The only part of the calculations that does not inspire confidence is the estimate of Indians in the eastern forests. Estimates were made by commanders of army posts and by government officials in the forest provinces, who had no possible way of knowing how many Indians they had under their jurisdiction; and most of the tribes were not visited at all. It is natural to suspect that the estimate is too high rather than too low, but at best we are left with a grave uncertainty regarding a figure that constitutes 5 per cent of the total.[3]

Distribution of Indians

The census forms contained a place for a "race" entry, and a "declaration of race" was made for all but one-tenth of 1 per cent of the counted

[2] Censo 1940 I, pp. xcii–xcix. As this total includes a large estimate in round numbers, the figures in the last three places mean little.

[3] This judgment of the forest estimates is based on conversations with persons who were personally familiar with the circumstances, chiefly in Cusco and Madre de Dios Departments.

TABLE I—"INDIANS" (A), SPEAKERS OF INDIAN LANGUAGES (B), AND SPEAKERS OF INDIAN LANGUAGES ONLY (C) AS PERCENTAGES OF TOTAL COUNTED POPULATION

	A	B	C
A. *Amazonas*	*20.37*	*23.76*	*5.28*
1. Chachapoyas	42.3	28.4	3.76
2. Bongará	35.3	25.8	17.0
3. Luya	6.6	25.7	4.4
4. Rodríguez de Mendoza	0.8	1.3	....
B. *Ancash*	*55.83*	*84.56*	*54.91*
1. Huarás	65.0	96.5	55.2
2. Aija	33.9	97.5	37.7
3. Bolognesi	49.9	95.8	34.3
4. Carhuás	80.0	99.2	79.9
5. Huari	61.5	99.7	81.5
6. Huailas	50.0	87.0	52.0
7. Pallasca	32.9	22.1	7.3
8. Pomabamba	65.5	89.8	67.0
9. Santa	22.7	38.4	7.9
10. Yungay	62.2	98.0	68.0
C. *Apurímac*	*70.02*	*99.59*	*86.22*
1. Abancay	66.7	98.8	77.1
2. Aimaraes	51.4	99.5	85.2
3. Andahuailas	80.5	99.5	89.2
4. Antabamba	55.9	99.7	80.5
5. Grau	68.5	99.4	87.5
D. *Arequipa*	*26.44*	*35.14*	*17.16*
1. Arequipa	13.4	14.1	3.5
2. Cailloma	80.3	97.0	66.4
3. Camaná	4.6	4.6	0.2
4. Caravelí	24.4	37.9	6.4
5. Castilla	36.7	64.6	32.4
6. Condesuyos	28.8	43.1	21.3
7. Islay	5.7	8.9	0.3
8. La Unión	60.0	99.6	59.0
E. *Ayacucho*	*75.94*	*99.01*	*82.39*
1. Huamanga	79.2	98.8	82.2
2. Cangallo	86.5	99.8	93.2
3. Huanta	75.2	99.0	83.8
4. La Mar	77.1	99.4	91.2
5. Lucanas	70.5	97.9	72.6
E. *Ayacucho (continued)*			
6. Parinacochas	52.0	99.4	65.6
7. Victor Fajardo	87.8	99.6	88.2
F. *Cajamarca*	*12.13*	*6.60*	*1.11*
1. Cajamarca	31.5	19.93	2.83
2. Cajabamba	11.2	....	....
3. Celendín	1.5	3.8	....
4. Contumasá	0.8	0.1	....
5. Cutervo	2.0	....	....
6. Chota	2.5	1.6	....
7. Hualgáyoc	5.6	1.8	....
8. Jaén	32.0	11.38	6.9
G. *Callao*	*2.87*	....	....
H. *Cusco*	*71.33*	*98.39*	*79.44*
1. Cusco	30.5	91.5	36.2
2. Acomayo	83.1	99.9	89.1
3. Anta	70.9	99.3	83.9
4. Calca	68.5	99.5	85.2
5. Canas	88.7	99.2	89.0
6. Canchis	86.9	98.4	83.0
7. Chumbivilcas	80.9	99.6	91.5
8. Espinar	94.9	99.8	89.2
9. La Convención	53.7	99.0	75.0
10. Paruro	70.9	99.6	90.3
11. Paucartambo	83.7	99.5	90.8
12. Quispicanchi	79.8	99.4	82.0
13. Urubamba	48.9	99.3	76.1
I. *Huancavelica*	*78.68*	*98.78*	*78.84*
1. Huancavelica	84.9	98.0	81.3
2. Angaraes	80.6	99.5	86.7
3. Castrovirreyna	60.2	96.7	50.2
4. Tayacaja	82.7	99.5.	86.3
J. *Huánuco*	*63.46*	*88.26*	*52.55*
1. Huánuco	58.9	80.3	43.2
2. Ambo	47.0	75.4	34.3
3. Dos de Mayo	69.9	98.9	61.5
J. *Huánuco (continued)*			
4. Huamalíes	58.6	98.8	61.7
5. Marañón	70.5	79.3	54.2
6. Pachitea	83.5	91.1	64.3
K. *Ica*	*29.19*	*14.53*	*1.82*
1. Ica	16.3	16.3	1.2
2. Chincha	60.2	10.4	3.4
3. Pisco	15.8	15.7	1.1
L. *Junín*	*60.85*	*78.83*	*31.71*
1. Huancayo	67.0	84.1	42.5
2. Jauja	55.0	69.6	19.7
3. Pasco	58.3	84.7	39.4
4. Tarma	67.9	82.0	32.0
5. Yauli	46.1	59.8	5.6
M. *La Libertad*	*12.86*	*1.28*	*0.17*
1. Trujillo	9.9	5.6	0.3
2. Bolívar	19.2	....	....
3. Huamachuco	33.7	....	....
4. Otusco	8.7	....	....
5. Pacasmayo	2.5	....	....
6. Patás	23.3	3.5	0.5
7. Santiago de Chuco	4.9	....	....
N. *Lambayeque*	*30.09*	*7.01*	*2.80*
1. Chiclayo	18.2	0.2	....
2. Lambayeque	44.5	15.5	6.3
O. *Lima*	*15.30*	*14.09*	*2.43*
1. Lima	4.9	9.3	0.2
2. Cajatambo	49.0	91.1	39.7
3. Canta	35.0	7.9	0.7
4. Cañete	44.7	9.6	0.7
5. Chancay	31.6	22.6	6.6
6. Huarochirí	37.7	9.6	0.5
7. Yauyos	36.8	40.4	9.8
P. *Loreto*	*38.16*	*38.71*	*13.46*
1. Bajo Amazonas	31.7	40.8	10.1
2. Alto Amazonas	52.3	43.5	23.9
3. Ucayali	44.3	32.6	15.2
Q. *Madre de Dios*	*25.88*	*17.03*	*5.37*
1. Tambopata	19.3	15.70	6.8
2. Manu	46.6	36.4	16.4
3. Tahuamanu	43.0	19.6	0.9
R. *Moquegua*	*46.17*	*48.52*	*24.33*
1. Mariscal Nieto	48.5	41.7	18.4
2. General Sánchez Cerro	43.8	55.2	30.2
S. *Piura*	*37.82*	*0.12*	*0.03*
1. Piura	53.7	0.2	....
2. Ayabaca	56.5	....	....
3. Huancabamba	66.8	....	....
4. Morropón	16.5	....	....
5. Paita	14.7	0.2	....
6. Sullana	7.9	....	....
T. *Puno*	*92.36*	*98.6*	*83.4*
1. Puno	89.5	96.9	77.6
2. Azángaro	95.5	99.4	88.9
3. Carabaya	82.9	98.5	87.2
4. Chucuito	94.5	99.7	85.5
5. Huancané	96.7	99.1	85.8
6. Lampa	93.3	99.1	81.7
7. Melgar	89.7	98.7	81.3
8. Sandia	85.9	98.9	81.1
9. San Román	86.2	95.5	73.2
U. *San Martín*	*25.02*	*32.85*	*12.54*
1. Moyobamba	0.2	4.3	1.3
2. Huallaga	17.6	11.1	3.5
3. Lamas	48.0	68.3	31.9
4. Mariscal Cáceres	15.9	9.1	1.4
5. Rioja	....	3.1	0.1
6. San Martín	22.8	32.5	8.3
V. *Tacna*	*52.17*	*51.78*	*16.09*
1. Tacna	30.7	27.7	6.2
2. Tarata	81.5	85.5	29.7
W. *Tumbes*	*1.46*	*0.48*	....

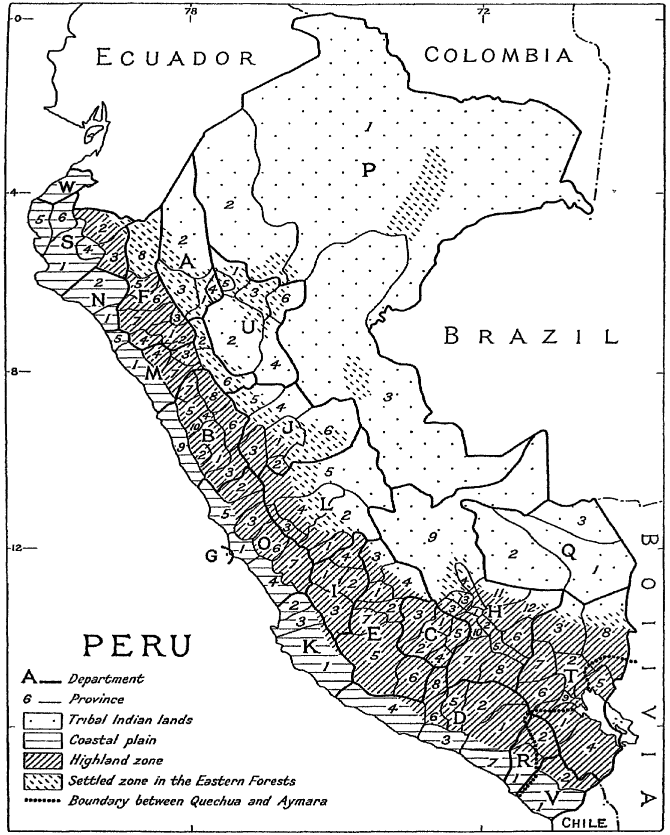

FIG. 1—Political and geographical divisions of Peru. Letters and numbers refer to departments and provinces, listed in Table I.

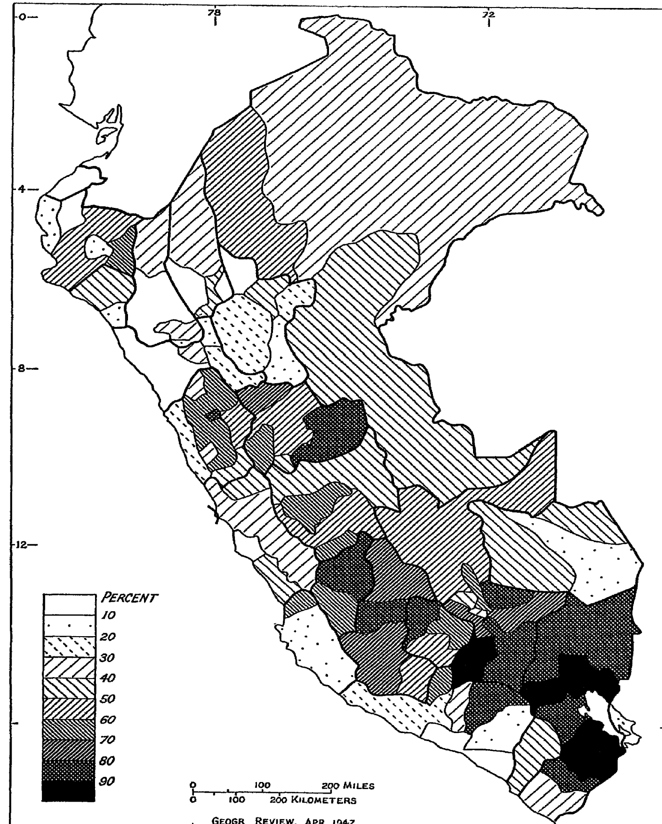

FIG. 2—Percentage of "Indians" to total counted population of Peru by provinces (Censo 1940 I, Table 41).

population of 6,207,967. The theory and practice of this declaration are clearly stated in the report:

In 1940, the investigation of races, as was explained during the work of preparation, was for sociological rather than anthropological purposes. No attempt was made to classify the population scientifically by its racial characteristics. Such a task should be undertaken by specialists and under different conditions from those surrounding a demographic census.

The difficulty of making a racial judgment of each individual is evident, especially when, in the nine cities in which the "family return" was used, the persons being counted had to make it themselves; consequently, the work of the census taker was limited to classifying the population by the categories already established by the national precedents referred to; that is to say, whites, mestizos [persons of mixed blood—J.H.R.], Indians, Negroes, and yellows [Chinese and Japanese—J.H.R.]. In accordance with this policy, the question in the returns read "Is he white, Indian, Negro, yellow, or mestizo?" and the corresponding instructions specified the form of answer to it as follows: "Persons who have no definite race, such as white, Indian, Negro, or yellow, will be marked mestizos."

Of the total population, 13 per cent of the replies to the question on race were supplied directly by the persons counted, and 87 per cent by the judgment or opinion of the census takers. Consequently, the accuracy of the information in the first case depends on the sincerity or subjective judgment of the inhabitants; in the second on the ability of those charged with making the judgment.[4]

The report goes on to say that it was found impossible to keep the categories "white" and "mestizo" distinct, so that they were lumped together in the tabulation of the returns for publication. The resulting figures for Peru as a whole are: whites and mestizos, 3,283,360 or 52.89 per cent; Indians, 2,847,196 or 45.86 per cent. The Negroes and yellows together make up only a little more than 1 per cent.[5]

It is evident that the Census Commission was endeavoring to distinguish and count the two great social and cultural groups into which the Peruvian population is divided, and not to separate races in a strict physiological sense. Yet the instructions were so worded that it seems highly probable that most census takers judged "race" by skin color and shape of face (i.e. tried to distinguish physiological race) instead of classifying each case according to such social and cultural criteria as dress, language, diet, and social position, which are the effective distinctions between "Indians" and "whites and mestizos" in all Andean countries. The figures would be much more significant if each person counted had been asked to classify himself, though of course no form of question can be devised that will classify every in-

[4] Censo 1940 I, pp. clxxviii–clxxix. My translation.

[5] Censo 1940 I, p. clxxx. We may note that if the estimate of 350,000 forest Indians is accepted and percentages calculated on the basis of the total population (7,023,111), the Indians amount to 3,410,000 or 48.5 per cent.

dividual without error when the divisions are social classes. However, let us look at the figures for what they are worth.

Figure 2 shows the relative strength of the "Indian" population by provinces, the smallest administrative division for which the figures are published. It will be noted immediately that the Indians are heavily concentrated in the mountainous parts of southern and central Peru and in the eastern forests, whereas the whites and mestizos are concentrated in the northern highlands and along the coast. The departments of Puno, Cusco, Apurímac, Ayacucho, and Huancavelica have the largest percentages of Indian population (70 to 92 per cent); Junín, in the center of the country, is somewhat lower (60 per cent); in parts of Ancash and Huánuco the percentage runs over 80 again, only to fall off abruptly as soon as the northern boundary of these two departments is passed. In the far north, parts of Piura run more than 60 per cent Indian.

The map, of course, shows only part of the Indian concentration in the forests, because its percentages are based on the persons actually counted, and the bulk of the population of the region is represented only by estimates. Except for isolated colonies of whites and mestizos, the forest is nearly pure Indian.

It will be noted that in the south urban areas tend to be whiter (Arequipa, Cusco, Lima), whereas in the north they tend to be more Indian than neighboring areas (Trujillo, Piura). Chiclayo and Huancayo are the chief exceptions. There seems to be no particular correlation between ease of communication and percentage of white and mestizo population: southern Peru, which is heavily Indian, has had a railroad for many years, whereas the northern mountains, which are non-Indian, have always been extremely inaccessible.

The census report quotes from an article by Dr. Jorge Basadre, Peru's most distinguished historian, in which he calls attention to the "revolutionary" meaning of the census returns.[6] He points out that it had been believed for many years that a majority of the Peruvian population were Indian, and that the proportions were unchanging and were reinforced by the physical differences between coast and highlands. The census, on the contrary, shows that the whites and mestizos are in the majority, and that this represents a change since 1876, when the Indians made up 57.6 per cent of the population. Also, the "race" differences cut across the zones of coast and highlands, and thus are not necessarily reinforced by them. Basadre calls

[6] Censo 1940 I, p. clxxxii, footnote 1. The article was published in the Lima newspaper *La Prensa*, July 27, 1941.

the census returns "revolutionary" because the place of the Indian in the Peruvian state has been a burning issue in politics and thought since at least 1920. The extreme views were held by the *indigenistas*, who taught that the country was predominantly Indian and consequently should have an Indian government, or at least a government preoccupied with Indian welfare, and the *hispanistas*, who felt that the best elements in the country were the whites and mestizos of Hispanic culture and that they should gradually absorb the Indians until Peru was a uniformly mestizo country like Venezuela or Colombia. The hispanistas naturally seized on the census returns as a powerful intellectual weapon against the indigenistas, and Basadre's interpretation is in high favor.

Although Basadre is undoubtedly correct as far as he goes, the detailed figures by provinces now available suggest further "revolutionary" conclusions, and the hispanista position is not nearly as attractive as it was in 1941. The important point is that the 52 per cent of whites and mestizos are not evenly enough distributed to give the country a uniform majority. They are concentrated along the coast and in the northern highlands, in districts where there are almost no Indians, whereas the Indians are concentrated in the mountainous center and south, in districts where there are very few whites and mestizos. Each group is in the majority in its own territory. In other words, the Indians in Peru are a minority, but they are a territorial minority like the French Canadians in Canada or the Catalans in Spain. The political theorists can go on from there.

Indian Languages

A vast number of Indian languages are spoken in Peru, but most of them are the languages of small forest tribes that were not counted in the census. In the settled parts of Peru there are only two Indian languages which are numerically important, both of which have their home in the southern highlands. The one with the largest number of speakers is the Inca language, usually called Quechua; the second is Aymará, spoken near the Bolivian border. Quechua and Aymará have very similar phonetic systems and grammar, but most of their roots and suffixes seem to be entirely independent, except for recent borrowings back and forth. They are usually classed in separate families but related on some higher level of classification because of their structural similarities. Neither language is related in any way to the great stocks of eastern South America or to languages outside the continent.

The Census Commission issued excellent instructions to the census takers for the collection of linguistic statistics, but it followed such peculiar methods

in tabulating the results that the figures are difficult to use. The original instructions read:

39. *Language.* (*a*) *What is his native language?* This question is intended to discover the language that the person interviewed learned to speak first; in most cases, the language of his parents.

b) *What other languages can he speak?* This question refers to languages that a person knows well enough to carry on a conversation.

The census taker is urged to use especial care in answering these questions; for this is an attempt to find out the original language of the person being interviewed and the one he learned to speak later. *For example:* The case of a person whose parents spoke nothing but Quechua and who consequently learned Quechua first, but later learned Spanish. This person should answer question (*a*) "Quechua" and question (*b*) "Spanish."[7]

Such questions should have enabled the commission to report how many native speakers of each language the population contained, and which groups were more highly bilingual. No such figures are given in the report. The attitude of the tabulators is explained in the introduction:

Since Spanish is the official language, the census had to be designed, in the first place, to show the extent to which Spanish has been spread. For this purpose, each person over five years of age, on being interviewed, was supposed to say whether or not he spoke Spanish, and in addition what Indian or foreign language. In this way, the statistical material collected serves to establish the various linguistic categories, showing clearly the cases in which a person knows one language only, or two or more. On the other hand, the tabulation of these data as functions of different attributes of the population, such as sex and race, has made it possible to extend the field of investigation almost without limit.[8]

In keeping with this policy of looking at the language statistics only from the point of view of the "official" language (Spanish), the following tables are given:

Table 45. Number of persons counted over five years of age, listed by languages and by departments and provinces. Language headings: Spanish. Spanish and foreign language. Spanish and Indian language. Indian language.

Table 46. Percentage of persons counted over five years of age speaking different languages, listed by departments. Same language headings.

Table 47. Table 45 broken down by sex.

Table 48. Table 46 broken down by sex.

Table 49. Number of persons counted over five years of age, listed by languages and by departments. Language headings: Spanish. Spanish and Quechua. Spanish and Aymará. Spanish and forest languages (*dialectos*). Spanish and English. Spanish and Italian. Spanish and German. Spanish and French. Spanish and some other foreign language. Spanish and Quechua or Aymará and some foreign language. Quechua. Aymará. Forest languages.

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[7] Censo 1940 I, p. 598. My translation.

[8] Censo 1940 I, pp. clxxxii–clxxxiii. Note how the census instructions are misrepresented in this passage. My translation.

Table 50. Number of persons counted over five years of age, listed by languages and by race. Same language headings.

Table 51. Percentages of the same.

Table 52. Table 50 broken down by race and sex.

Table 53. Table 51 broken down by race and sex.[9]

It is difficult to look over these tables without feeling that they deliberately present the figures in such a way as to exaggerate the apparent importance of Spanish in Peruvian life. We may regret that a little more impartiality was not possible in this volume and hope that more detailed tables of the language returns will be published later.

How many persons speak Quechua and Aymará in Peru? The answer to even so simple a question as this is complicated by the way the figures are presented in the report. In calculating the number of speakers of a language, it is customary to count children under five years of age as well as adults, on the reasonable assumption that the children will speak their parents' language: children over three have usually learned it already. Yet all the language tables in the report exclude children under five.

Table 49 gives 2,444,523 persons who speak Quechua, including 1,625,156 who speak Quechua only; these figures represent 46.5 per cent and 31.1 per cent respectively of the total persons counted over five years of age (5,228,352). If we apply these percentages to the total calculated population (6,673,111) exclusive only of the estimated forest Indians, we have: total Quechua speakers, 3,102,996; Quechua only, 2,175,337.

Obviously the total of native speakers of Quechua must lie between these two figures; and if we assume that half of the bilinguals are native speakers of Quechua, we shall probably be fairly safe, though this estimate may favor Spanish somewhat. We have then: native speakers of Quechua in Peru, 2,589,000. Of these, 60 per cent live south of Huancayo and speak either the Cusco or the Ayacucho dialect (about 30 per cent each). These are the purest dialects, and, to judge from Figures 3 and 4, the most concentrated ones. Junín (16 per cent), Ancash (12 per cent), and Huánuco (7 per cent) have each its own dialect, together making up 35 per cent of the Quechua speakers in Peru; the remaining 5 per cent are scattered over the northern departments.[10]

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[9] Censo 1940 I, pp. 159–176.

[10] This information about dialect distribution has been compiled by mapping the major dialect areas from reports of missionaries and travelers and correlating them with the census figures by estimation. The percentages are admittedly impressionistic, but probably fairly accurate. Acknowledgments are especially due to John Ritchie (Lima), Kenneth G. Case (Andahuailas), Edmundo Arce (Huanta), and Víctor Navarro del Aguila (Ayacucho). See also J. E. Garro: The Northern Kechuan Dialects of

It is not so easy to estimate the numbers of Quechua speakers in the other Andean countries, for neither Ecuador nor Bolivia has ever taken a census. The following figures are certainly conservative, however: Peru, 2,589,000; Ecuador, 1,250,000 (total population, 3,000,000); Bolivia, 752,000 (total, 3,500,000); total, 4,591,000.

The true total is probably nearer 5 million. In any case, Quechua is by far the most important native American language in present numbers, having more than twice as many speakers as its nearest rival (Maya). Here are a few Old World languages for comparison (rounded figures): Greek, 7 million; Danish, 4 million; Norwegian, 3 million; Lithuanian, 2½ million; Albanian, 1 million.[11]

For Aymará, Table 49 gives 231,935 as the total number of speakers, including 184,743 who speak Aymará only—respectively 4.4 per cent and 3.5 per cent of the counted population over five years of age. Applying these percentages to the total calculated population, we have: total Aymará speakers, 295,000; Aymará only, 235,500.

Dividing the bilinguals as we did for Quechua, we have: native speakers of Aymará in Peru, 265,250. The Aymará speakers are clustered along the Bolivian border in the departments of Puno, Tacna, and Moquegua. A sharp line divides Aymará from Quechua; it was traced accurately for the first time in 1940–1941 by Harry Tschopik, Jr.[12]

Peruvian Aymará is only a small fraction of the whole; Aymará is the chief Indian language of Bolivia, where it has perhaps one million speakers, and there are said to be a few in northern Chile also.

For the forest languages (*dialectos*), Table 49 gives 19,344 counted individuals over five years of age. The total as corrected by the methods used above is 24,600, to which must be added the estimated 350,000 forest Indians who were not counted. As these total figures for forest languages do not mean much, owing to the uncertainty involved and the great number of

Peru, *Amer. Anthropologist*, Vol. 44 (N. S.), 1942, pp. 442–450; Javier Pulgar Vidal: Algunas observaciones sobre el lenguaje de Huánuco, *Rev. Univ. Católica del Perú*, Vol. 5, No. 37, Lima, 1937, pp. 801–819; and P. M. Benvenutto Murrieta: El lenguaje peruano, Vol. 1, Lima, 1936.

[11] Population figures for Ecuador and Bolivia from "Censo 1940 I," p. xcii; Old World languages, *World Almanac*, 1946, p. 581. We may note in passing that Quechua has more speakers now than ever before and shows no signs of decline. It has, however, lost some ground in relative position to Spanish in Peru; that is, Spanish has increased faster than Quechua.

[12] See his article on the Aymará in the "Handbook of South American Indians," edited by J. H. Steward, *Bur. of Amer. Ethnology Bull. 143*, Vol. 2, Washington, 1946, pp. 501–573. Aymará has lost a great deal of ground to Quechua since the seventeenth century; it used to be spoken all over Puno and the southern part of the department of Cusco, with extensions into Apurímac and Arequipa. The circumstances of this loss have never been explained. See also my article on the Inca in the same volume of the "Handbook," pp. 183–330.

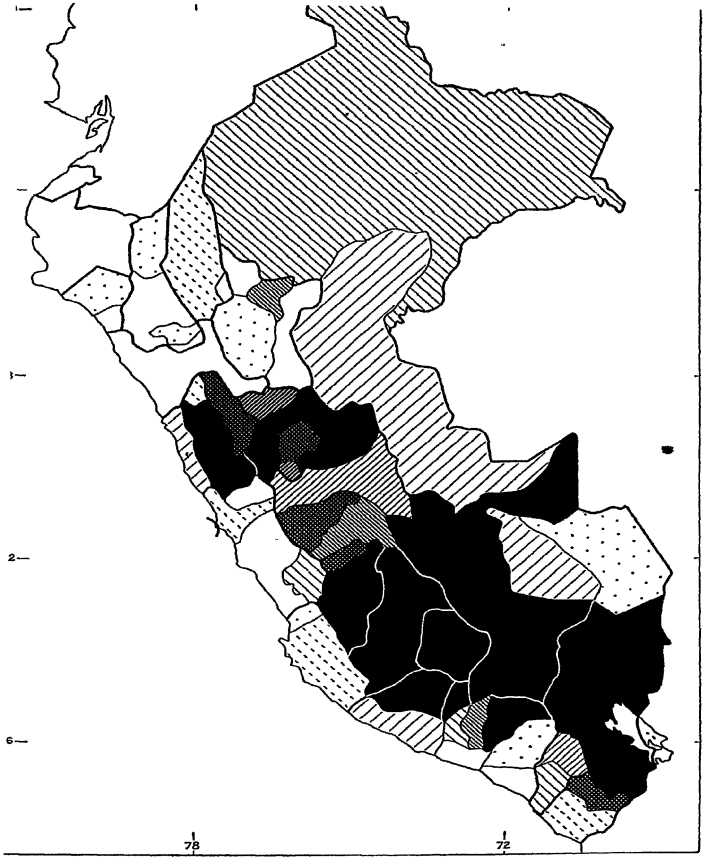

FIG. 3—Percentage of all speakers of Indian languages to counted population of Peru by provinces (Censo 1940 I, Table 45). Key as in Figure 4.

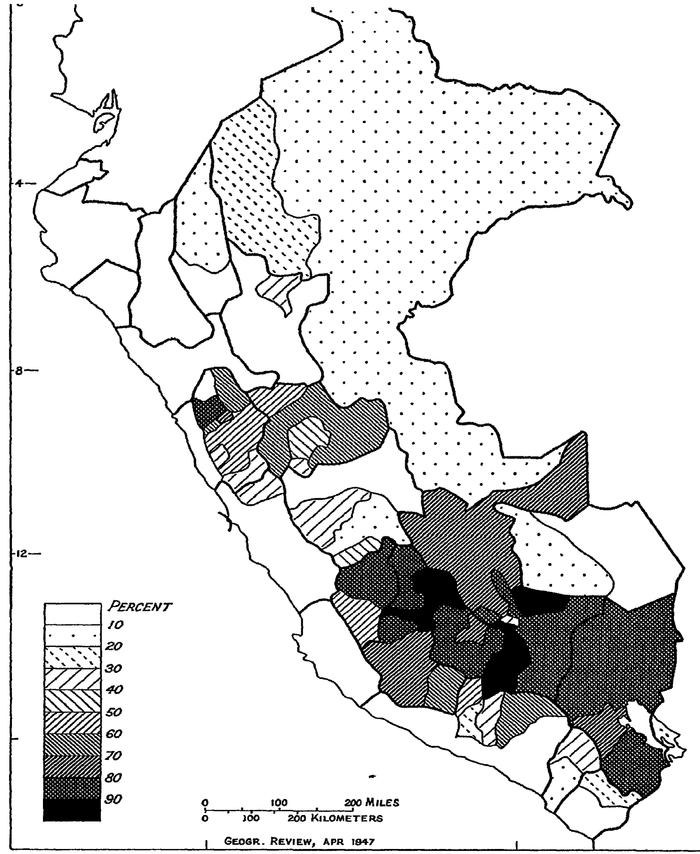

FIG. 4—Percentage of speakers of Indian languages only to counted population of Peru by provinces (Censo 1940 I, Table 45).

independent languages represented, our chief concern with them is that the counted total of 19,344 "contaminates" the figures for certain provinces on which our maps are based.

Figures 3 and 4 and columns B and C of Table I are derived from the absolute figures of "Censo 1940 I," Table 45.[13] This table lumps all Indian languages together in columns 4 and 5, but in the coastal and highland provinces the total figure for Indian languages obviously refers to Quechua and Aymará only. For the most part it refers to Quechua in the forest also; for, as we have seen, only 19,344 speakers of forest languages were counted in the whole country, and many more speakers of Indian languages than that are listed for the forest provinces. By a comparison of Tables 45 and 49, however, it is possible to estimate how much of the totals for provinces refer to forest languages. The following corrections should be made:

Amazonas: Bongará Province has mostly forest languages. Cajamarca: most of Jaén has forest languages. Cusco: less than 1 per cent of La Convención has forest languages. Huánuco: 3 per cent in the forest areas. Junín: 1 per cent in the forest areas. Loreto: 25 per cent over the whole department. Madre de Dios: 25 per cent over the whole department. San Martín: less than 1 per cent.

With these allowances, the shading on Figures 3 and 4 can be taken to represent percentage of Quechua or Aymará over the entire country, but it must always be remembered that the percentages are based on counted population *only.*

Language Correlations

Figures 3 and 4 show clearly that Quechua and Aymará speakers are concentrated in roughly the same areas for which the census returned a high percentage of Indians; that is, in the highland zone south of Huancayo and in the mountainous parts of Ancash and Huánuco. The Spanish-speaking areas likewise correspond to the areas where whites and mestizos predominate—the mountains north of Ancash and the coast. Parts of Piura and Apurímac, however, form interesting exceptions to the general correlation.

Between the Spanish and Quechua or Aymará areas are zones with a high percentage of bilinguals, such as northern Ancash, the mountainous parts of the department of Lima, and the Pacific slopes of the southern highlands. The department of Junín forms a large bilingual interruption in the continuity of the Indian language mass in the mountains. There is no apparent correlation between the importance of Spanish and the presence of transportation facilities.

[13] The percentages were checked by Barbara B. Rowe.

Although the coast is predominantly a Spanish area, there are surprisingly large percentages of bilinguals in some provinces (Santa, Caravelí, Mariscal Nieto, and Tacna). Inasmuch as only a negligible amount of Quechua had spread to the coast in pre-Spanish times and Spanish replaced other, now extinct Indian languages in that region, the presence of any Quechua at all on the coast is an indication of the great vitality of the language (or of Aymará in the case of Tacna) in the historical period.

The amount of Quechua spoken in the eastern forests is also surprising. As we have seen, the forest languages account for only a small part of the total speakers of Indian languages reported from that region, and it follows that the greater part of the percentages given for forest provinces refer to Quechua speakers. In the parts of the forest closest to the Quechua-speaking mountain areas (the lowland parts of Huánuco, Cusco, and Puno; see Figure 1) the percentages of Quechua speakers are only slightly lower than in the mountains themselves, and even in the more distant forest provinces of Loreto there seem to be at least 15 per cent native speakers of Quechua in the settled population. Only in Madre de Dios, the remotest and most sparsely settled department in the republic, is Quechua a negligible factor. Clearly, the penetration and exploitation of the forested *montaña* that have been going on for the past 50 years have not been carried on exclusively by Spanish-speaking Peruvians.

The percentages for language and "race" make an interesting comparison (Table I). Agreement is close in some provinces; in others there seems to be no correlation at all. In the department of Piura, for example, three provinces are listed with 50–70 per cent Indians, yet none of them yielded even 1 per cent of speakers of Indian languages. On the other hand, the department of Apurímac shows an excess of 9 to 34 per cent of persons speaking no Spanish over persons classified as Indians. Apparently, in the Quechua-speaking areas many persons of mestizo or white appearance speak Quechua, and in the Spanish-speaking areas many persons of Indian appearance speak only Spanish. For the country as a whole, a quarter of a million, or 15 per cent of the counted population who spoke only Quechua, were classed as whites or mestizos, and more than 400,000, or 17 per cent of the counted population who spoke only Spanish, were classed as Indians. Of the bilinguals, about 45 per cent were classed as Indians and 55 per cent as whites or mestizos. In most of Peru language is certainly the best single guide to social class, and the language returns probably indicate the *socially* Indian population with greater exactness than the classification by "race," which must have been made in practice by skin color and form of features. Nevertheless, the

errors of the "race" classification are compensating to such a degree that the *total* figure for "Indians" corresponds closely to that for Indian languages. Our estimates of the numbers of native speakers of Quechua and Aymará yield a figure of 42 per cent speakers of Indian languages for the country as a whole (less the forest tribes), which is not very different from the 46 per cent yielded by the racial figures.

Table 52 gives the correlations by race and sex. The men show a greater tendency toward bilingualism than the women in both "races." This tendency is very noticeable in specific cases in southern Peru, and the women seem to be generally more conservative in other cultural matters.

The Census Commission devotes three pages of solemn nonsense to a correlation between the amount of Spanish spoken and the amount of education in each department.[14] Naturally enough, no department shows a higher percentage of education than of Spanish speakers: no education is offered in Quechua or Aymará in Peru, and the 35 per cent of the population that speak no Spanish are consequently wholly illiterate and shut out from public affairs by an insuperable language barrier. The language difference is perhaps the most important facet of what Peruvians call "the Indian problem" because in practice it denies access to courts and schools to persons speaking only Quechua or Aymará, whatever the intention of the government may be. It would be interesting to see what could be done if Quechua and Aymará were legalized for teaching and official business in the provinces where they are spoken by a significant fraction of the population.

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[14] Censo 1940 I, pp. clxxxiv–clxxxvi.

AGROCLIMATOLOGY AND CROP ECOLOGY OF THE UKRAINE AND CLIMATIC ANALOGUES IN NORTH AMERICA*

M. Y. NUTTONSON

THIS study represents an agroclimatic and crop-ecological approach on the part of an agronomist to plant introduction into the Ukraine and the exchange of plant material between that country and North America. It is a direct outgrowth of the problems of the huge postwar agronomic plant-introduction tasks brought about by the urgent need to facilitate a speedy rehabilitation of war-devastated agricultural areas. The necessity for immediate large-scale utilization of introduced plant material often precludes its careful testing through the usual varietal field trials; hence the need for caution in the selection of such material at its source.

The study is also, however, an outgrowth of nonemergency plant-introduction experiences where careful varietal field trials of introduced plant material have been possible. Regionally, there is often a need for crop diversification and improvement as well as for economy in time, effort, and cost in the varietal field trials. A less empirical attitude toward the selection of plant source areas for a given region and a less arbitrary attitude toward the selection of areas of field trials for a given plant material of a definite agroclimatic origin would result in much saving of time and effort. It is fully appreciated that the elasticity of adaptation of a given plant variety is in no way limited or predetermined by the agroclimatic or ecological characteristics of its place of origin or discovery. It is also appreciated that under completely different environmental conditions a variety may often perform better or worse than, or just as well as, in its original environment and that this can be ascertained by empirical trials. It is felt, however, that where the needs are purely regional and the economical considerations of obtaining results are of considerable importance, an orientation to the agroclimatic origin of the plant material may be desirable.

OBJECTIVE AND METHOD OF PROCEDURE

The objective of this study is to organize, define, and analyze the various distinct agroclimatic conditions prevailing in the different parts of the

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* This article is one of a series of similar studies made by the Office of Foreign Agricultural Relations and published in offset form by the Department of Agriculture. In order that these useful studies may be brought to the attention of geographers, this article, in condensed form, is presented here. The tables of botanical and climatic data have been omitted because of limitations of space.—EDIT. NOTE.

Ukraine and to compare them with conditions in various agroclimatic regions of North America in order to discover "climatic analogues." "Climatic analogues" are areas that are enough alike with respect to some of the major weather characteristics affecting crop production, particularly during the growing period, to offer a fair chance for the success of plant material transplanted from one area to its climatic counterpart.

Meteorological data of all the available weather stations of the Ukraine and comparable stations of North America were the main sources of material. The elements of comparison are mean monthly and yearly temperatures, average monthly, seasonal, and yearly precipitation, precipitation-effectivity indices (Thornthwaite's method), length of frostless periods, and latitudes. Phenological records of a number of varieties of wheat and rye grown in various parts of both regions, and also crop geography, vegetative-cover belts, and soil and physiographic characteristics, have been taken into account. After all such elements of the environment of a given Ukrainian meteorological station had been computed and studied, a search was made among American meteorological stations for a similar climatic and latitudinal environment. The North American environment found most nearly to resemble that of the Ukrainian station was recorded as climatically analogous to it.[1] In addition, a separate study was made for the April-October fraction of the year to discover climatic analogues for areas of spring-planted crops. A map of the Ukraine showing the natural vegetation belts, the meteorological stations, and the American areas to which each of these stations belongs climatically is presented with this paper (Fig. 1).

A further check of a number of established climatic analogues has been made possible through a comparative study of phenological data for a few wheat, corn, and rye varieties grown in climatically and latitudinally analogous areas of America and the Ukraine. These phenological data, and also some comparative studies of the summation of the accumulated day degrees required after planting to bring the crop to a definite phenological stage or to maturity, are to be presented in considerable detail at a later date.

Ukraine: General and Comparative Geography

The Ukraine occupies the southwest corner of the European part of the Soviet Union and in population and economic development ranks second

[1] A complete list of the climatically analogous North American meteorological stations, with their county and state locations and some of the points in which they differ from their respective "opposite numbers" in the Ukraine (65 stations), is given in the "Agro-climatic Chart" of the original version of the article; a selection from this list appears in Table I.


METEOROLOGICAL STATIONS OF THE UKRAINIAN S.S.R. AND AREAS CONTAINING THEIR CLIMATIC ANALOGUES IN THE UNITED STATES
Mixed Forest Belt
Forest Steppe Belt
Steppe Belt
Area added to Ukraine since World War II
SLANTING TYPE: State name right of station refers to year-round climatic analogues - for winter and spring crops
VERTICAL TYPE: State name right of station refers to April-October climatic analogues - for spring crops only
*Only fragmentary meteorological data available - not enough to formulate climatic analogues
STATUTE MILES
50 0 50 100
50 0 50 100 150
KILOMETERS
U S DEPARTMENT OF AGRICULTURE
NEG. 644 OFFICE OF FOREIGN AGRICULTURAL RELATIONS
OFAR

Table I—Selected Examples from the Agro-climatic Chart of the Ukraine and Climatic Analogues in the United States

For each station in the Ukraine the latitude and altitude (feet) are given. Line T gives mean monthly and yearly temperatures (°F); absolute maximum and minimum temperatures; last killing frost of spring and first killing frost of fall; and number of frostless days. Line P gives precipitation, monthly and yearly (inches); and precipitation-effectivity index (P/E). "*U.S.*" indicates climatic analogue in the United States based on fall- and spring-planted crops; "*U.S. Suppl.*," climatic analogue for spring-planted crops only.

		J	F	M	A	M	J	J	A	S	O	N	D	Year	Max.	Min.	Frostless.	Days
Kharkov	50°04′ T	18.0	21.0	29.5	44.6	57.9	64.6	68.7	66.0	55.9	44.6	32.0	23.2	43.9		−32.6	May 3–Oct. 2	151
	476 ft. P	1.2	1.1	1.3	1.3	1.6	2.8	2.7	2.0	1.2	1.6	1.5	1.3	20.0	P/E	49.9		
	U. S. Lewistown, N. C. Montana, 47°02′; 4006 ft. Somewhat cooler summers. 2 inches less precipitation.																	
	U. S. Suppl. Washburn, W. North Dakota, 47°20′; 1731 ft.																	
Alekseevskaya	49°11′ T	20.8	23.4	31.3	44.8	58.8	64.0	68.2	66.4	57.6	46.0	33.4	25.5	45.0	101.1	−20.7	Apr. 23–Oct. 14	173
	602 ft. P	1.0	1.1	1.2	1.2	2.0	2.7	3.0	1.8	1.6	1.7	1.2	1.1	19.4	P/E	46.5		
	U. S. Emory, S. E. Montana, 45°35′; 3200 ft. Slightly cooler. 4 inches less precipitation.																	
	U. S. Suppl. Washburn, W. North Dakota, 47°20′; 1731 ft.																	
Voroshilovgrad	48°35′ T	19.4	22.5	32.2	47.1	60.8	67.3	72.0	69.3	58.3	46.4	34.0	25.7	46.2	104.2	−38.2	Apr. 27–Sept. 28	164
	151 ft. P	1.0	1.1	1.2	1.4	2.0	2.4	2.3	1.4	1.3	1.4	1.5	1.4	18.5	P/E	44.0		
	U. S. Bloomfield, E. Nebraska, 42°40′; 1702 ft. Slightly warmer summers. 4 inches more precipitation.																	
Kirovograd	48°31′ T	21.6	24.3	32.7	45.9	59.5	65.1	69.6	67.3	57.9	46.9	34.7	26.6	46.0	99.7	−26.2	Apr. 26–Oct. 5	161
	418 ft. P	0.9	0.9	1.1	1.1	1.7	2.6	2.6	1.8	1.3	1.8	1.1	1.1	18.3	P/E	36.8		
	U. S. Great Falls, N. C. Montana, 47°35′; 3360 ft. Slightly cooler summers. 3 inches less precipitation.																	
	U. S. Suppl. Eureka, E. South Dakota, 45°50′; 1881 ft.																	
Mariupol	47°06′ T	21.4	24.3	32.5	45.9	59.5	67.3	73.0	71.1	60.3	48.6	35.6	27.5	47.1	96.1	−19.5	Apr. 18–Oct. 18	183
	241 ft. P	1.4	1.4	1.2	1.4	1.4	2.0	1.8	1.4	1.5	1.6	1.2	1.2	17.6	P/E	43.6		
	U. S. Greeley, E. Nebraska, 41°35′; 2021 ft. Somewhat warmer summers. 5 inches more precipitation.																	
	U. S. Suppl. Redfield, E. South Dakota, 44°50′; 1301 ft.																	
Odessa	46°30′ T	26.4	28.9	35.6	45.7	57.9	65.7	70.5	69.8	61.3	52.2	40.3	32.2	48.9	94.8	−14.6	Apr. 5–Oct. 30	208
	218 ft. P	1.1	1.1	1.1	0.9	1.1	2.1	2.1	1.5	1.0	1.3	0.9	1.1	14.5	P/E	33.9		
	U. S. Kimball, W. Nebraska, 46°35′; 4697 ft. Somewhat cooler October to January. 2 inches more precipitation.																	

among the member republics of that country, yielding precedence only to the Russian S.F.S.R.[2] Before the war, the Ukraine, which covers only about one-fortieth of the territory of the Soviet Union, produced approximately a quarter of the wheat of the Union, a third of the barley, a quarter of the corn, and nearly three-quarters of the sugar beets.

The southern extremity of the Ukraine lies in the same latitude as southern Montana, northern South Dakota, southern Minnesota, central Wisconsin, and northern Michigan; the northern extremity lies in the same latitude as southern Alberta, southern Saskatchewan, and southern Manitoba. A study of the climate of the Ukraine in terms of North American areas located within the same latitudes and within similar thermal and precipitation distribution patterns suggests certain United States areas of the Interior Plains. Most of these areas lie in the northern part of the Great Plains province, but some of them fall also within the eastern and western lake sections of the Central Lowland (Fenneman's classification).

In its general physical aspect most of the Ukraine, with its vast continuous grassland plains and low plateaus, its broad belt of rich black earth, extending southwest-northeast over three-fourths of its area and decreasing in humus content toward the north and south, resembles the wide grasslands of the North American prairies to the west of the Atlantic forest and the more extensive grasslands of the great plateaus that reach the eastern base of the Rocky Mountains. The replacement of the luxuriant vegetation of the fertile black earth (chernozem) in the northern part of the Ukrainian grasslands by the less luxuriant and shorter vegetation of the brown and brown chestnut soils in the more arid southern and eastern parts suggests the transition from the tall-grass to the short-grass areas of the United States. There are also parallel soil transitions in the differences between the black soils of the north end of the United States chernozem belt, in the Dakotas, and the brownish-black soils and redder subsoil of its south end, in Texas.

Within the grasslands, green in summer and brown in autumn, are large areas of the most valuable agricultural land of both countries and some of the finest wheat land in the world. The level plains and rolling prairies of the immense Ukrainian steppes, highly conducive to large-scale farming, suggest the topography of large areas of the central part of the North American grasslands.

Forests still occupy much of the Ukraine, mostly in the northern and northwestern parts, though a great deal of land has been cleared. The forests are in gray ash-colored podzol soil areas that are not without some similarity

[2] See Theodore Shabad: Political-Administrative Divisions of the U.S.S.R., 1945, *Geogr. Rev.*, Vol. 36, 1946, pp. 303-311.

to certain parts of the forest and cutover podzol areas of the United States. The transition from the luxuriant forests of the northwestern Ukraine to the arid and sparsely covered short-grass areas of the southeast suggests the gradual transition from the luxuriant and varied forest of the eastern United States to the treeless, thinly grass-covered plains on the west side of the interior continental basin.

Although representing in general a featureless and continuous plain, the topography of the Ukraine is considerably diversified in detail. Hills, low ridges, rivers, creeks, gullies, and ravines break the monotony of the plain. The average elevation is about 550 feet above sea level. In the southeastern part is the Donets Ridge, the highest point of which is at 1200 feet. In the west is the Volynian-Podolian plateau, a continuation of the Carpathian foothills, with an elevation of a little less than 1300 feet. These two ridges are linked by the Dnieper Ridge, which runs from east to west and is transected by the Dnieper River, the most important river of the Ukraine and the third-longest river (1400 miles) in Europe (after the Volga and the Danube). The Dnieper divides the country into two distinct areas: the right or west-bank area and the left or east-bank area.

Climate of the Ukraine and Its North American Analogues

The Ukraine is subject to a Temperate Zone continental climate. Warm, moist winds from the Atlantic exert a moderating effect in the northwest, which becomes progressively less noticeable eastward and southeastward.

The precipitation distribution pattern resembles that of the Middle West, with its predominantly summer-maximum type of rainfall. It suggests also the precipitation distribution pattern of the Prairie Provinces of Canada. The heaviest precipitation in most of the Ukraine falls in May, June, and July; the annual total decreases from northwest to southeast, ranging from 25 inches in the northwest to 11 inches in the southeast. Heavier precipitation occurs only in the higher parts of Carpathian Ruthenia, and the precipitation-effectivity indices for the great majority of Ukrainian meteorological stations range from 22 to 58. The annual precipitation, precipitation-effectivity indices, and precipitation distribution pattern of the Ukraine are also characteristic of a number of North American areas located approximately between the 92nd and 110th meridians and north of the 40th parallel. Only a few of these, however, lie more or less within the range of the Ukrainian latitudes, mainly in Montana, North and South Dakota, Nebraska, and Minnesota and Saskatchewan and Manitoba.

The summers of the Ukraine are warm, even hot in the south. The mean July temperature usually ranges from 65° to 73° F.; however, it exceeds

70° F. at only a relatively few stations. Frequent thawings are characteristic of the winter in a large part of the country, and the winters are neither so long nor so cold as in many North American areas in the same latitudes. The mean January temperature for the majority of Ukrainian meteorological stations ranges from 17.5° to 27.5° F. The frostless period ranges from 122 to 212 days, and the total summation of accumulated day degrees above 50° F. ranges from 2400 to more than 3600.

Satisfactory year-round climatic analogues for a great number of Ukrainian meteorological stations are available in the United States. Some are located in the exact latitude of the corresponding Ukrainian station, but many are 2° to 4° to the south, a few 7°. The generally milder winters in the Ukraine may be attributed to the lower altitudes as compared with those of most of the United States climatic analogues.

United States meteorological stations selected as year-round climatic analogues are fairly similar to their counterparts in the Ukraine in the major elements of comparison of this study; namely the temperatures throughout the year, the total precipitation and its monthly and seasonal distribution, the precipitation-effectivity indices, and, to a considerable extent, the length of growing period and the total summation of day degrees. The climatic analogues in the United States are found in north-central, southwestern, and southeastern Montana, western South Dakota, and western and eastern Nebraska. However, a number of Ukrainian stations in the higher parts of the Carpathian Mountains find their climatic counterparts in eastern lower Michigan and western New York.

The relatively mild winters of the Ukraine do not permit the establishment of year-round climatic analogues in a number of other areas of the United States where the latitude range and the climatic conditions during the growing period are similar to those of the Ukraine; but if attention is limited to the climatic conditions prevailing during the growing period of the spring-planted and fall-harvested crops, that is, to the April-October fraction of the year, then additional climatic analogues in the United States for spring-planted crops can be established in North and South Dakota, Minnesota, and Wisconsin.

Natural and Agricultural Belts: The Mixed Forest Belt

The climatic, soil, and physiographic diversity of the Ukraine together with the considerable diversity in the natural vegetation[3] permits a division

[3] Lists of the chief plant species of the natural vegetation are given in the original version of the rticle.

of the country into three natural belts. Each of these can be subdivided into more specific agricultural-climatic regions.

The Mixed Forest (Polesie) Belt occupies about 10 per cent of the area of the Ukraine. It is the northernmost, coldest, and wettest part of the country, a region of lowlands and marshlands, gray forest podzol soils, and large coniferous and broad-leaved forests. Its southern limit runs from the boundary of the Ukraine on the west along the 50th parallel to Kiev and northeast along the Seym River.

Agriculturally the belt is devoted mainly to animal husbandry, hay crops, and potatoes, under fairly intensive cultivation. It is characterized by an abundance of moisture, a sufficient and sometimes excessive snow cover, and relatively mild winters and cool summers. The annual precipitation ranges from 20 to 25 inches and decreases from west to east. The precipitation is well distributed through the year but is distinctly of the summer-maximum type, about 8 inches occurring in the May-July period. The average relative humidity in June (measured at 1 p. m.) is about 60 per cent. The average annual temperature ranges from 38° to 44° F., decreasing from south to north and from west to east. The mean July temperature ranges from 64° to 66° F., the mean January temperature from 21° to 23° F. The precipitation-effectivity indices range from 50 to 59.

The climate is favorable for the production of winter cereals. Summer temperatures are lower than in other regions of the Ukraine, with a consequent lower summation of heat units or accumulated day degrees during the growing period. The amount of annual and seasonal precipitation in absolute figures is not great, but the comparatively low summer temperatures coupled with the poor physical soil conditions tend to make that amount excessive in effect.

The most suitable crops for the belt as a whole are considered to be winter rye, potatoes, fodder crops, oats, and buckwheat; winter wheat, spring wheat, and barley are of relatively limited importance. The left-bank area contains somewhat less marshy, less sandy, and better soils than the right-bank area. The left-bank area is one of the main centers of hemp culture in the Soviet Union, and the belt as a whole is regarded as one of the highest-yielding potato regions of the Union. Natural meadows and pastures are good and abundant. Clover, timothy, winter vetch, and seradella are the important hay crops. Sugar beets are grown only along the southern border. Carrots, peas, inferior tobacco (*makhorka*), winter and spring rape, poppy seed, and cow pumpkins are also produced. The local silage crops include sunflower, corn, sweet clover, lupine, and horse bean.

United States year-round climatic analogues are found mainly in north-central Montana, spring-crop climatic analogues in northern Minnesota also. A phenological comparison shows that spring wheat is sown in this belt of the Ukraine from about April 5 to May 1 and that the harvest usually begins July 28 to August 1; in Montana sowing of spring wheat begins about April 1 and ends May 1 and harvest begins on August 1; in Minnesota sowing of spring wheat begins about April 11 and ends May 1 and harvest begins about August 1. The mean monthly temperature at which planting of spring wheat begins in both the Mixed Forest Belt and the climatic counterparts in Montana and Minnesota is about 40° F. The amount of accumulated day degrees required to bring spring wheat to maturity also provides an interesting comparison. When analyzed on the basis of the same spring-wheat varieties, there is an indication of rather similar requirements of thermal constants in a number of areas of the climatic analogues established for this belt.

The Forest Steppe Belt

The Forest Grassland or Forest Steppe (Lesosteppe) Belt is a plain cut rather badly by numerous gullies and ravines, a transition area of partly degraded or podzolized, and often leached, chernozem soils. It occupies about 40 per cent of the territory of the Ukraine and consists of alternating forests, large steppe grasslands, and relatively small forest islands, groves, or tree clusters amidst huge, luxuriant meadows of thick grass. The wood patches and coppices are composed mainly of broad-leaved trees, chiefly oak, and the accompanying shrubs and herbaceous vegetation. Pine forests grow on the sandy terraces of steppe rivers and on chalk deposits. As a whole, forest associations cover a comparatively small area.

The steppe areas in the northern part of the belt are covered with tall, thick grass, which becomes less high and thick southward and southeastward. Because of the abundance of dicotyledonous plants, these steppes are referred to as "meadow steppes" or "northern steppes," in contrast with the "grass steppes" of the Steppe Belt, where the true grasses (monocotyledons) predominate. Seasonal changes in the composition of the vegetative cover of the undisturbed meadow steppes are pronounced and involve a considerable number of dicotyledons in addition to more than 20 species of true grasses.

Agriculturally this belt is mainly an area of intensive sugar-beet and winter-wheat production. Precipitation is of the summer-maximum type and is usually sufficient for crop production; precipitation-effectivity indices range from 40 to 52. Eastward, the summers become somewhat drier and

the winters more severe. The Dnieper River divides the belt into two distinct climatic and agricultural regions.

The Right Bank Region. The Right Bank Region is characterized by a sufficient and well-distributed summer rainfall and by a mild winter with a fairly heavy snowfall and a warm and fairly humid summer. The average annual precipitation ranges from 18 to 22 inches, of which 7 to 8 inches or more falls in the May-July period; it decreases slightly from northwest to southeast and from the higher to the less elevated areas. The mean July temperature ranges from 66° to 69° F., the mean January temperature from about 21° to 23° F.; the relative humidity of June (measured at 1 p. m.) is about 54 per cent. The mild climate, sufficient snow cover, well-distributed rainfall, and fairly good soils are all conducive to relatively large yields of various field and orchard crops. The leading crops of the higher areas (600 to 1000 feet) and the more podzolized soils are winter wheat, corn, sugar beets, grain feed, and soybeans. Winterkilling of wheat is almost unknown, and this is one of the highest-yielding winter-wheat regions of the Soviet Union. However, the abundance of precipitation in some years may lead to severe rust infestation and to decrease in the gluten content. The precipitation of 4 to 6 inches in July and August is favorable for the growth of corn, but the total heat summation is insufficient for the ripening of the late-maturing varieties; early-maturing varieties have made this one of the best corn regions of the Union. Sugar beets and corn do not yield too well on the more podzolized soils and the higher areas. Potatoes are especially important on the better soils of the northern part, and hemp and barley of high malting quality are also grown there. The abundant precipitation is favorable for fodder crops. Vetch and oat mixtures in most of the region and clovers in the northern part are the main local hay crops. The southern part is well suited to corn and soybeans, especially the early varieties. In the northern part the summation of heat units is not sufficient for soybeans, and peas, lentils, kidney beans, and, especially, spring and winter vetch for seed take their place. Mangel, carrots, some watermelons, pumpkins, hemp, and poppy seed for oil are also produced. Buckwheat is grown on the poorer sandy-clay soils.

The Left Bank Region. The Left Bank Region has somewhat severer winters and slightly less precipitation than the Right Bank Region. The annual precipitation ranges from 17 to 21 inches and decreases southeastward. The snow cover is usually sufficient except in the southeast, where in places the depth is seldom more than 6 inches at the end of the winter (i.e. before the spring thaw). The mean January temperature ranges from 17.5° to 19.5° F.;

the range of the mean July temperature is about the same as in the Right Bank Region. The summers are sometimes hot but are without pronounced droughts. Summer temperatures increase from northwest to southeast. The average relative humidity in the southeast in June is about 52 per cent. This is a region of extensive sugar-beet cultivation. In the southeastern part the yields are high—they are, in fact, among the highest in the Soviet Union—but in the northwestern part they are much lower because of poorer and less productive soils. It is also because of these poor sandy-clay soils that winter rye competes here with winter wheat. The grain crops grown in this region are about the same as in the Right Bank Region, but there is also a considerable production of spring wheat in the southeastern part, since winter wheat, although it yields well, is subject to winterkilling during severe and snowless winters. Besides winter rye and winter wheat, the leading crops of the northwestern part are oats, sugar beets, and fodder crops; buckwheat, peas, horse beans, poppy seed for oil, and pumpkins are also produced. Potatoes and tobacco are of some importance. The fodder crops are about the same as in the Right Bank Region; seradella and lupine for cover crops are also grown. In the more northern areas a considerable acreage is devoted to hemp. The leading crops of the southeast are sugar beets, winter wheat, winter rye, corn, and hay. Soils and moisture permit high yields of corn, but because of the relatively short frostless period only the earliest varieties can be raised. Spring wheat (of the hard-wheat type) yields considerably less than winter wheat and is grown only in the most southern and southeastern areas adjacent to the Steppe Belt. Alfalfa does well, and so do sainfoin, vetch and oat mixtures, spring vetch for seed, Sudan grass, mangel, soybeans, horse beans, pumpkins, and hemp. Potatoes and oats are grown in the more northern areas of the southeast.

United States year-round climatic analogues for the Forest Steppe Belt of the Ukraine are found mainly in north-central, southwestern, and southeastern Montana, spring-crop analogues also in northern and southwestern Minnesota, eastern and western North Dakota, and eastern South Dakota. A phenological comparison shows that spring-wheat sowing begins in the Forest Steppe Belt of the Ukraine about March 26 to April 20; in Montana between April 1 and May 1; in Minnesota between April 11 and April 21; in North Dakota between April 1 and April 21; and in South Dakota between March 21 and May 1. Corn is planted in this belt from April 30 to May 16 and even a little later, according to the locality; in South Dakota and Minnesota between May 1 and May 11; and in Montana and North Dakota after May 11. The best-yielding variety of corn in the southern

part of the Forest Steppe Belt of the Ukraine is the American variety "Minnesota 23," which matures there on the average in 124 days (114 to 133 days); the dates of harvesting are the same as those of the climatically analogous areas in South and North Dakota, Minnesota, and Montana. The summation of day degrees required to mature the corn crop is about the same for specific climatic analogues when comparison is based on the same variety.

The Grassland or Steppe Belt

The Grassland or Steppe Belt comprises the semiarid and arid, almost forestless grasslands of the Ukraine southeast of the Forest Steppe. The approximate border line between the belts runs from Benderi in Bessarabia to Ananyev in the former Moldavian ASSR, thence to Kirovograd, Poltava, and Kharkov. The Steppe Belt, the outstanding part of the Ukrainian scene and its main landscape feature, occupies nearly one-half of its area. The topography consists of monotonous plains with few gullies and ravines. It is a belt of rich chernozem, which passes toward the more arid south into the dark-brown chestnut soils. Insufficient precipitation and snow cover and frequent droughts are rather characteristic of many parts of this belt, especially in the east and south.

Because of the predominance of monocotyledons in the natural vegetative cover, the steppes of the Steppe Belt can be referred to as "grass steppes." The natural vegetation of the grass steppes can be divided into two major types of plant formations and steppes: the dicotyledonous *Stipa* steppes and the *Stipa-Festuca* steppes. In the former the xerophytic, narrow-leaved, sod-forming true grasses predominate but dicotyledonous vegetation is also plentiful. In the latter, which occupy the arid southern part of the Steppe Belt, the xerophytic, narrow-leaved, sod-forming true grasses are the typical plant formations and there is relatively little other vegetation.

The grass cover of the Stipa-Festuca steppes is sparse and conducive to development of short-lived annuals and ephemeral perennials of short growing period. Scattered over these steppes are spring-flooded meadows of mixed-plant association in which the familiar quack grass predominates. In addition to various grasses and bulbous plants, trees and bushwoods stud the steppes where moisture is favorable. Terraces and groves of trees are found within overflow areas of rivers, along river valleys, and on their slopes. Only relatively small islands of the original vegetative cover have been preserved undisturbed, since almost all the steppe lands are at present under cultivation.

The chernozem soils of the steppes decrease in depth and humus content and increase in alkalinity southward toward the more arid areas. The southern chernozem passes into the dark chestnut soils, which occupy a narrow zone on the north coast of the Black Sea, on the right bank of the lower Dnieper, and in the western part of the north coast of the Sea of Azov.

The Steppe Belt is preponderantly a territory of grain culture, with winter wheat grown mostly in the western part and spring wheat in the eastern part. The climate differs considerably from that of the other two belts. The differences can be summarized as a greater aridity and a greater danger of droughts; smaller precipitation-effectivity indices, owing to higher annual temperatures and smaller amounts of precipitation; higher summer and lower, less stable winter temperatures; frequent thawing and freezing; and a poorer snow cover. It might be said that as a whole the territory south of a line running roughly from Kishinev through Dnepropetrovsk differs climatically from the territory to the north in being exposed to easterly and southeasterly winds, which prevent the snow from becoming thick. This condition, as well as the rainless springs and the return of easterly winds and frosts in May, is often a contributory cause of poor harvests here. However, the climatic conditions within this belt vary considerably from west to east and north to south.

Agriculturally the Steppe Belt can be subdivided into four regions: Semiarid Northern Steppe, Eastern Arid Steppe, Steppe of Higher Elevation, and Southern Arid Steppe.

The Semiarid Northern Steppe. This is a dicotyledonous Stipa steppe. This chernozem region represents in both its natural and its agricultural aspects a transition from the greater humidity, greater precipitation, milder winters, and cooler summers of the Forest Steppe Belt to the arid and distinctly more continental climate of the southern and eastern steppes of the Steppe Belt.

The western part is less arid than the eastern part, and winter conditions are more favorable. The yearly precipitation ranges from 16 to 19 inches, of which 6 to 7 inches of rainfall occurs in the May-July period. The relative humidity in June is about 50 per cent. The mean July temperature of the eastern part ranges from 70° to 72.5° F., the mean January temperature from 20° to 23° F. in the west and from 19.5° to 21° F. in the east.

In the eastern part winterkilling of the less hardy varieties of wheat often takes place, because of lower temperatures and the insufficient snow cover, which on the average is seldom more than four inches in depth at the end of the winter. Because of the danger of winterkilling, considerable

areas are devoted to spring wheat, which, however, is often subject to greater damage by drought than winter wheat.

In the western part winter conditions, summer precipitation, and heat summation are conducive to reliable and consistent yields of crops, mainly winter wheat, corn, and fodder. The hay crops include alfalfa, sainfoin, Sudan grass, sorghum, and winter rye. Beets and carrots, watermelons and pumpkins, soybeans, and barley are also cultivated. In the eastern part the same crops are grown, and, in addition, spring wheat, potatoes, vegetables, rice, and sweet clover. Rice and truck crops are grown under irrigation, also a considerable part of the alfalfa and of the local semisweet sugar beets.

The Eastern Arid Steppe. This is also a dicotyledonous Stipa steppe. It occupies the Ukrainian part of the Don drainage basin.

Precipitation ranges from 16 to 18 inches a year, of which about 6 inches falls in the May-July period. The mean July temperature ranges from 70° to 72° F., the mean January temperature from 15° to 19° F. The average depth of snow cover at the end of the winter is usually less than 4 inches.

The main crops are wheat, sunflower, corn, and barley. Wheat is of leading importance, and spring wheat is preferred because of the frequent danger of winterkilling. Only the hardier winter-wheat varieties compete with spring wheat. Hard spring wheats are preferred and yield as much as the soft spring wheats. Sunflower seems to be badly affected by broomrape, which limits its area of cultivation, and corn does not yield as much in this region as in the preceding ones because of the smaller amount of precipitation and shorter length of the growing period. Barley is of considerable importance, and some areas are also devoted to watermelons and pumpkins. Sugar beets are grown in the vicinity of Kharkov. Potatoes and anise are produced on a limited scale. Fodder crops occupy a relatively unimportant area and are of less consequence than in the preceding regions because of less favorable climate. Winter rye is of considerable importance on the poorer and lighter soils in the Kupyansk district.

Winters are somewhat milder, and more favorable for winter wheat, in the more southern parts; the yield of winter wheat there is, in fact, almost double that of spring wheat. Hard spring wheat outyields soft spring wheat. The largest area in this region devoted to corn is also found in the southeastern part.

The Steppe of Higher Elevation. This region occupies the Donets Heights areas of the Artemovsk district and of the Voroshilovgrad and Stalino Oblasts. Elevations reach 1200 feet above sea level. The climate is characterized by a somewhat greater and better-distributed precipitation than that

of the surrounding Eastern Steppe, and by a considerably better snow cover. The landscape, the general natural conditions, and the agricultural possibilities all resemble those of the Forest Steppe Belt. Truck crops, fodder crops, and fruit are cultivated. Hardy varieties of winter wheat, spring wheat, corn, sunflower, and barley are among the main local field crops. The local hay crops include alfalfa, sainfoin (especially on the chalk soils), Sudan grass, and winter rye. Sorghum, sweet clover, corn, cow pumpkins, and watermelons are grown locally for silage. Carrots, mangel, and semi-sweet sugar beets are the main root crops. Potatoes are grown but are subject to "degeneration" diseases, which affect their yield. Some drought-resistant oats are also grown locally.

The Southern Arid Steppe. This is a Stipa-Festuca steppe of southern chernozem soils. It consists of parts of the Odessa, Nikolayev, and Kherson Oblasts and of the Melitopol area.

The climate is pronouncedly arid, the average annual precipitation being 14 to 18 inches, in the more southern parts only 12 inches. Precipitation in the May-July period ranges from less than 5 to 6 inches and in July and August is about 3 inches. The mean July temperature ranges from 73° to 75° F., and the relative humidity in June is mostly less than 50 per cent.

Droughts and crop failures, especially of spring crops, are fairly frequent. The winters are relatively warm, though seldom snowless. The mean January temperature ranges from 21° to 23° F. A relatively long frostless period in conjunction with the higher summer temperatures permits production of cotton, grown here under irrigation as well as without irrigation. The early American variety No. 1306 seems to be among the best. This is predominantly a region of cotton, high-gluten-content winter wheat, and barley. Corn, peanuts, sesame, and grain sorghum are of secondary importance.

In spite of very little snow cover, the warm winters make winter-wheat production less hazardous in this steppe than in the northern and, to an even greater extent, the eastern steppes. This region is less reliable, however, for spring-wheat production than the other two because of greater danger of drought. The yields of the local winter-wheat varieties, which exceed those of spring wheat, as well as their high gluten content, make them distinctly preferable in the wheat-growing areas of the region.

United States year-round climatic analogues for the Steppe Belt of the Ukraine are found in western and eastern Nebraska, southeastern Wyoming, western South Dakota, and north-central Montana, and a few spring-crop analogues are also found in some of the areas of eastern South Dakota and

western North Dakota. A phenological comparison shows that spring-wheat sowing begins in the Steppe Belt approximately between March 15 in the southernmost areas and April 20 in the northernmost areas; in the climatically analogous areas in Nebraska, North and South Dakota, and Montana the beginning dates of spring-wheat sowing range from March 11 in Nebraska to April 21 in North Dakota. Harvesting of spring wheat in this Ukrainian belt often begins between July 12 and July 20, which suggest the dates of the beginning of harvesting in Nebraska and South Dakota. Corn is planted in the Steppe Belt from the middle of April, or even a little earlier in the southernmost parts, to the middle of May; these dates apply also to the climatically analogous areas in Nebraska, North and South Dakota, and Montana. The best corn varieties of the Ukrainian belt are the American varieties "Minnesota 13," which matures in the southern arid steppes in about 105 days (96 to 113 days); "North Dakota White," which matures in the southeastern arid steppes in about 97 days (91 to 102 days); "Sterling," which matures in the central and southern steppes in 104 days (100 to 108 days); "Brown County," which requires 125 days (109 to 141 days) to mature in the northern steppes and only 99 days (96 to 101 days) in the southern steppes; and "Minnesota 23," which requires 118 days (103 to 133 days) in the northern steppes.

A rather detailed comparison has been made of the phenology of specific varieties of a number of crop species grown under climatically analogous conditions in various geographical areas, and also a comparison of the thermal-constant requirements of these varieties. These studies, in the opinion of the author, point to a rather pronounced tendency for similarity in phenological plant behavior under similar climatic environments in approximately the same latitudes. A statistically analyzed presentation of this subject is to be made available in a separate paper.

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NOTE.—Transliteration into English of the Russian titles of papers and of the names of their authors has mainly followed the recommendations of the Library of Congress. In a number of Russian papers, however, the titles are given in both Russian and some other language, usually English. In such cases the given transliteration of the author's name and translation of the title of his paper has been preferred.

A GEOGRAPHIC SYSTEM OF VEGETATION

A. W. KÜCHLER

ONE of the great handicaps to the development of the science of phytogeography is the confusion that exists in the minds of both botanists and geographers with regard to terminology. A number of terms have evolved during the past two generations. These terms are given different meanings by different authors. An author may use two different terms for the same type of vegetation, or different types of vegetation may be designated by the same term by different authors or even by the same author.

To illustrate this confusion in the nomenclature of vegetation types, a few examples may be cited. In his book on Asia,[1] Stamp uses the term "deciduous forests" on one map and "monsoon forests" on another map for the same type of vegetation. The variation is not employed to lend a certain elegance of style or to avoid repetition but is used on vegetation maps, where such a procedure is unacceptable. This is a minor transgression, however, as compared with what we find on White and Foscue's vegetation map of "Anglo-America."[2] On this map the barren desert of the lower Colorado and the lush Iowa prairies are under the same designation—an inexcusable grouping even in view of the small scale of the map. On the same map "northern" forests, named from the latitude, are set off against "spruce-ponderosa" forest, which is a poor name combining a genus in the English language with a species of another genus in Latin. De Terra leans in the same direction with his peculiar usage of "semi-deciduous forest" and "mixed forest."[3] According to Phillips[4] the most important plant community of central Tanganyika is one that he calls the "*Berlinia-Brachystegia*-Other Species Woodland communities." He cites other investigators and the names they have given to this one vegetation type—no fewer than nineteen! A large assortment of such confusions could be instanced. I must emphasize that I am not criticizing either the authors or their work, but I do wish to show the pitfalls with which our path is strewn when we make investigations in the field of phytogeography. In certain cases more dis-

[1] L. D. Stamp: Asia, 4th edit., New York, 1938, Fig. 92 (p. 207) and Fig. 189 (p. 350).

[2] C. L. White and E. J. Foscue: Regional Geography of Anglo-America, New York, 1943, Fig. 5 (p. 13).

[3] Hellmut de Terra: Component Geographic Factors of the Natural Regions of Burma, *Annals Assn. of Amer. Geogrs.*, Vol. 34, 1944, pp. 67–96; reference on pp. 79–84.

[4] John Phillips: Some Important Vegetation Communities in the Central Province of Tanganyika Territory (Formerly German East Africa), *Journ. of Ecology*, Vol. 18, 1930, pp. 193–234; ref. on p. 213.

cretion might have been advisable, but in general the culprits must be excused on the ground that an accepted phytogeographic classification is nonexistent. From the point of view of a critical terminology many terms are of local value only; for example, Central Forest, Southern Forest, Coast Forest. Such expressions can be applied almost anywhere, each time with a new meaning and conveying nothing to the reader unfamiliar with the area under discussion. They are useless in analyzing vegetation and should not appear on a vegetation map.

The lack of an accepted terminology makes it difficult to join vegetation maps of contiguous areas when the maps are by different authors; compilation of a world map of vegetation becomes an exasperating if not hopeless task.

The science of plant geography has remained largely in the hands of botanists, who have failed to adopt a uniform nomenclature. The extent of the confusion in botanical circles was made clear by Du Rietz when addressing the Sixth International Botanical Congress on the classification and nomenclature of vegetation units.[5]

> At the Fifth International Botanical Congress (Cambridge, 1930) the author presented an attempt to parallelize some of the most prominent terminological systems of phytosociology, demonstrating the chaos prevailing even in the application of such fundamental terms as "association" and "formation" . . . Unfortunately there does not seem to be much hope at present of arriving at a general agreement in this respect. The leading phytosociological schools of the present day are not willing to sacrifice any essential part of their traditional terminology for the purpose of an international agreement.

At the same congress another prominent leader in the field, Braun-Blanquet,[6] spoke of "the need for establishing order in the ever increasing chaos in the description of vegetational groupings."

Even the best-known botanical schemes have not found much support among geographers. Raunkiær's system of life forms is unsuitable for a geographic approach. So are systems based on floristics with terms like "Salicornietum radicantis," "Salicornion," and "Salicornietalia."[7] Du Rietz uses "socion," "sociation," "consociation," "association."[8] This is not the place to criticize the relative merits of the botanists' systems. The fact re-

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[5] J. E. du Rietz: Classification and Nomenclature of Vegetation, *Proc. Sixth Internatl. Botan. Congr., Amsterdam, 1935,* Vol. 2, pp. 104–105.

[6] J. Braun-Blanquet: Un prodrome des groupements végétaux, *Proc. Sixth Internatl. Botan. Congr., Amsterdam, 1935,* Vol. 2, p. 105.

[7] J. Braun-Blanquet: Plant Sociology, translated, revised, and edited by G. D. Fuller and H. S. Conard, New York and London, 1932, p. 374.

[8] J. E. du Rietz: Classification and Nomenclature of Vegetation, *Proc. Fifth Internatl. Botan. Congr., Cambridge, 1930,* p. 74.

mains, however, that none of them has been found acceptable by a majority, even among botanists.

In describing any type of vegetation, the forms actually existing must be considered before references to habitat are made. Only after the vegetation has been fully described can climate, soil, bios, and culture find a place in the discussion. The point of view exhibited in the following quotation deserves full support.

> Vegetation should be primarily characterized *by its own features,* not by habitat, indispensable as is the study of habitat for the understanding of its nature and distribution. It is the *structure* and *composition* of a plant community that we must first ascertain and record as the secure basis of all subsequent knowledge.[9]

One of the primary tasks confronting geographers is to formulate a classification of vegetation for their own specific use.

> Native vegetation is an expression of the composite physical environment. It is the integration of all physical factors, past as well as present, and as a consequence often provides a better basis for classifying and judging the potentialities of environments than any other one single factor or set of factors.[10]

> Vegetation types are the visible reflection of the climates. . . . Even the rhythm of the seasons finds expression in the changing aspect of the vegetation cover.[11]

> The plant-cover of an area forms the best key to the sum-total of the climatic conditions.[12]

Most geographers hold the same or similar points of view, and it seems strange, therefore, that more attention has not been devoted to the study of vegetation in American geographical circles—at least until one actually beholds the green garment of our globe. Life manifests itself in a perplexing variety of forms, and the earth's vegetation is no exception. But life also obeys the great laws of the universe, and it is at this point that the work of the phytogeographer begins. Were there no law, his efforts would be futile. The fact that the vegetation is grouped and distributed all over the world in a definite pattern permits him to make reasonable investigations and to draw logical conclusions. It permits him also to devise a classification and a nomenclature that will be his most important tool.

The best statement the author has been able to find on the nature of an ideal terminology was made by Dr. Barnhart:

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9 P. W. Richards, A. G. Tansley, and A. S. Watt: The Recording of Structure, Life Form and Flora of Tropical Forest Communities as a Basis for Their Classification, *Journ. of Ecology,* Vol. 28, 1940, pp. 224–239; reference on p. 229.

10 V. C. Finch and G. T. Trewartha: Elements of Geography: Physical and Cultural, 2nd edit., New York and London, 1942, p. 483.

11 P. E. James: An Outline of Geography, Boston, New York, etc., 1943, p. 6.

12 M. I. Newbigin: A New Regional Geography of the World, New York, 1929, p. xvii.

The rules of terminology ought to be simple and based on reasons clear enough and strong enough that everyone understands them and is disposed to accept them.[13]

This precise statement is entirely acceptable, but if it is adopted as a basic formula, it becomes at once one of the most formidable barriers on the road to our goal! Terms that are "simple" and "clear" seem a matter of course in a terminology, but with regard to vegetation types nothing is simple or clear.

Among the factors that complicate the formulation of satisfactory terms may be listed the variety of vegetation types, the transitions between types, and the terms themselves.

The vegetation of the continents presents an intricate pattern of different types. Even though a given type may recur several times, it is by no means always the same. This results in the application of one term for all occurrences by some observers and a separate term for each occurrence by other observers. Just how much a type must differ from another before a new term is justified is a difficult question to answer.

What has been said of vegetation types applies also to their divisions and subdivisions. If the process of dividing is continued logically, the considered area becomes so small that one passes from geography into ecology and had better resort to the quadrat method, which is not geography. It is quite impossible to say where to draw the line between geography and ecology, since circumstances vary from one case to the next. We are here confronted with one of the major questions of phyto*geographic* methodology and hence also of terminology: how much detail is permissible in a study of vegetation that is to stay within the boundaries of geographic research?

The second, and perhaps the most perplexing, problem is caused by the fact that types of vegetation do not generally possess clear boundaries. One type merges into the next, and between the areas of distinct types there appears a belt of varying width the vegetation of which belongs to neither one of the distinct types. Transitions are difficult to analyze. One needs only to remember Forrest Shreve's repeated efforts to define the edge of the desert. If there is no agreement on the definition of a major term, how can one establish boundaries?

A transition between two very different life forms—for example, trees and grasses—is less troublesome than one that lacks contrast. For instance, there are innumerable places where it is almost impossible to distinguish between trees and shrubs, and any boundary line shown on a map is largely arbitrary. Transitions are very frequent indeed. Of an Alaskan region

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[13] *Proc. Fifth Internatl. Botan. Congr., Cambridge, 1930,* p. 559.

Griggs said: "Transitions, in fact, occupy more ground than areas which could be called typical."[14] To make matters worse, transitions usually proceed irregularly, so that the transition between two distinct types of vegetation may adopt different, yet characteristic, forms.

A third great problem lies in the terms themselves. A given term conveys a different meaning to different authors. Some students of vegetation attempt to avoid this danger by coining new terms. Others use foreign terms or foreign terms translated into English—a dangerous method unless an unequivocal definition is given every time.

The question arises whether a clear and simple classification of the world's vegetation is possible, and in his correspondence with colleagues and in numerous discussions the author has often met with a negative attitude. This pessimism he considers unfounded, and if he ventures to propose a method that he hopes may prove acceptable to geographers, he does so because he is convinced that a systematic approach to the geographic study of vegetation is both necessary and possible.

There are, of course, a considerable number of terms that are well established in phytogeography. Every geographer is familiar with *paramo, prairie, heath, taiga, tundra, savanna, maquis, steppe,* and numerous others. Many of these terms are variously defined. *Tundra, taiga, steppe,* and a few others are used in several continents, but the great majority of terms refer one to a definite area. These names should be used as in the past, though perhaps they should be more clearly defined wherever that is possible or desirable. But they have not been found adaptable to a general, unified system that can be expressed on maps. The author likes and frequently uses these terms and proposes to continue to do so. Their use is not exclusive of the phytogeographic classification presented in this paper.

A New Classification Proposed

The new classification proposed herein endeavors to follow Dr. Barnhart's behest. The author hopes that its rules are clear and simple, that they are intelligible and acceptable to every geographer. The approach is physiognomic, which has a triple advantage for geographers: (1) direct observations can be used as a basis of classification; (2) floristic terms are avoided; (3) cartographic representation is simplified.

The author is happy to acknowledge his inspirational debt to Köppen. Climates, no less than vegetational types, are difficult to express in formulas,

[14] R. F. Griggs: The Vegetation of the Katmai District, *Ecology*, Vol. 17, 1936, pp. 380–417; reference on p. 395.

and it is to Köppen's lasting credit that he succeeded in devising a system that is used by geographers all over the globe and has been a stimulus to further efforts at classification. In developing his system Köppen was greatly influenced by considerations concerning the distribution of vegetation, and it is therefore not difficult to see that a classification of vegetation may be developed along parallel lines. The principles are essentially the same in both systems: a few basic groups, designated with capital letters, and a larger number of qualifications, designated with small letters. Combinations of capital letters appear primarily in transitions from one type to another, though this is not a necessary implication. Another feature common to the two systems is the arbitrary nature of some of the boundaries. It does not seem possible to do away entirely with arbitrary choice, and such choice is, of course, open to criticism. But the author feels that the arbitrary boundaries are too few in number, and not of sufficient significance, to threaten the value of the classification as a whole. The Köppen classification describes the climate of any region with satisfactory detail. It does not state what weather one may expect there on a given day, though the climate of a place is ultimately the sum total of individual weather conditions. Likewise the classification presented in this paper describes the vegetation of any region with satisfactory detail. It does not give the species that make up this vegetation.

The fundamental geographic division of the plant kingdom is that between the woody plants and the nonwoody or herbaceous ones. The appearance of the latter in the landscape is relatively uniform; they are therefore all combined under the one capital letter G. The appearance of woody plants varies much more, both as regards height and as regards general characteristics. There are four primary groups: B, broadleaf evergreen; D, broadleaf deciduous; E, needleleaf evergreen; and N, needleleaf deciduous. "Needleleaf" includes scalelike leaves such as those of some cypresses. The term is usually but not always synonymous with "coniferous." To these are added the capitals M for mixed growth of D and E, and S for semideciduous vegetation, composed of B and D.

These capitals stand for trees unless they are qualified by s or z. It is not always necessary or even desirable to refer to the height of trees (l, m, t), but it is imperative that one of these small letters be added if both trees and shrubs occur on the same ground, with trees dominant.

The capitals may be qualified by appropriate small letters. On maps of small scale this is often not necessary, and a capital letter may well stand alone. The following list gives the capital letters and four groups of small

letters. These qualifying letters should always be arranged in the order of the groups from which they are taken.

Capitals:	B	broadleaf evergreen woody vegetation
	D	" deciduous " "
	E	needleleaf evergreen " "
	N	" deciduous " "
	M	mixed (D and E) " "
	S	semideciduous (B and D) " "
	G	grasses and other herbaceous plants
Small Letters:		
Group I:	l	low; with trees: maximum height: 10 meters " grasses: " " ½ meter
	m	medium; with trees: height 10–25 meters " grasses: " ½– 2 "
	t	tall; with trees: minimum height 25 " " grasses: " " 2 "
Group II:	h	herbaceous plants other than grasses
	s	shrubs with a minimum height of 1 meter
	z	" " " maximum " " 1 " (dwarf shrubs)
Group III:	a	arid. Vegetation distinctly xerophytic or completing its life cycle within a few weeks. Bare ground between plants is conspicuous.
	b	barren. Vegetation largely or entirely absent.
	c	continuous dense growth. With G it signifies continuous sod.
	d	dominant. Attached only to a feature that is considerably more prominent than others in the same group.
	g	galeria forms and any vegetation limited to the vicinity of bodies of water (e.g. mangroves).
	i	interrupted. Trees and shrubs stand so far apart that their crowns frequently do not touch. With G it signifies bunch grass.
	p	growth singly or in groves (of trees and shrubs: parks, etc.) or in disconnected patches (of G).
	r	rare. The feature is not frequent yet is conspicuous.
Group IV:	e	epiphytes occur in abundance.
	j	lianas are conspicuous.
	k	succulents are conspicuous.
	w	aquatic vegetation, whether submerged, as *Sargassum*, or floating entirely or in part on the surface, as water lilies (*Nymphaea alba*) or duckweed (*Lemna minor*). Plants that root under water but carry important parts above the surface (e.g. mangroves) are not included in w.

Evidently not all four groups are needed every time. If there is more than one capital, each one will have its own set of small letters. The qualifying letter always follows the feature it qualifies, so that the small letters always stand on the right side of the capital letter to which they belong. Any group of qualifying letters containing the letter d should be placed before any other qualifications or groups thereof, so that the group con-

taining the d is separated by the d from the features to which the d does not apply. All qualifying letters refer to features on their left. If more than one capital letter is required, the feature most prominent in the landscape is placed first. A few examples will illustrate this.

A moss or lichen tundra: Gh
An area thinly covered with sagebrush: Bzi
Taiga: E
Elfin or tropical high-altitude forest: Ble
Selva: Btej
Chaparral scrub: Bs
" " with scattered live oaks: BsBi
Savanna: GDp
" (low grasses, occasional shrubs): GlDsr
" (tall ", galeria forests): GtDpBg
Broadleaf deciduous forest: D
Pine forest with ground layer of blueberry bushes: EmDz

The examples indicate that considerable detail can be shown whenever wanted. One of the advantages of this system is its adaptability to maps on a wide variety of scales. Large-scale maps will show more formulas per unit area, and possibly longer ones, than small-scale maps.

The author has started work on the great and difficult project of drawing a unified vegetation map of the world. He urgently invites his colleagues everywhere to send him vegetation maps of any part of the globe, or to indicate to him where such maps or any relevant information can be obtained.

GRASSLAND, "TREELESS," AND "SUBHUMID"

A DISCUSSION OF SOME PROBLEMS OF THE TERMINOLOGY OF GEOGRAPHY

JAMES C. MALIN

GEOGRAPHERS and historians seem to be unaware of the extent to which they are committed to subjective rather than quantitative terminology. One region is described in terms of another, the one with which the writer of the description happens to be familiar. Because the civilization of western Europe and eastern America developed in a predominantly forest environment, the prevailing geographical terminology is that of the forest or high-rainfall climate. As forest man moved into the prairie of Indiana, Illinois, Kentucky, and the country farther west, he called it "treeless" and "subhumid." These negative terms measured the new region by the characteristics of the accustomed forest environment and found it deficient. If a grassland man had been entering a forest region, by the same principle he would have been justified in calling the forest "grassless" and "superhumid." The point to be emphasized is that a geographical area should be described in positive terms that delineate its characteristics in quantitative language, and by independent standards or units of measurement.

The interior of North America is a grassland, and, according to the definitions of plant ecology, grass is the normal or climax vegetation. If the grass is plowed up and the land abandoned, it tends to return to grass through a process of succession of plants, beginning with weeds and ending, after many years, in substantially the original species of grasses, together with their associated forbs. In a forest country the corresponding succession tends to restore the original forest.

As regards the terms designating the volume of moisture available in any region, the accepted nomenclature is based on forest man's standards of western Europe and eastern America, taking the normal of those regions as humid. Variations from this subjective concept of normal are subhumid or superhumid. But Illinois is humid for corn, the South Carolina coast is humid for rice, Cuba is humid for sugar cane, the plains country west of the 100th meridian is humid for blue grama grass, the Arizona desert is humid for cacti and creosote bush, and the southern Idaho desert is humid for sagebrush. If the term "humid" or "subhumid" is used, then the question arises, "Humid or subhumid for what?" For each of the plants just listed as illustrations, the volume of rainfall is normal in its proper region. A rain-

fall of about five inches is a normal amount for the moist desert where creosote bush and cacti are native, and a rainfall of 15 inches is normal for blue-grama-grass areas.

NATURAL REGIONAL ADEQUACY

To approach the problem from a somewhat different angle, any area of the earth's surface should be treated in terms of its adequacy for all native vegetation and animal life within its limits. An area is never super or sub anything for its native fauna or flora, and it is not deficient in anything that constitutes its natural condition. When man introduces his so-called "civilization" from one area into another, he cannot expect to be successful unless he utilizes plants and animals for which the new area is normal. His transplanted civilization becomes successful to the degree to which he is able to harmonize it with the principles of natural regional adequacy. The plains country is normal for hard spring and hard winter wheats, the bread wheats, and they do not grow successfully where the rainfall is greater than about thirty inches. Western Kansas has a normal climate for the grain sorghums, but it is subhumid for corn. Likewise, white-faced cattle (Herefords) will thrive on the plains where buffaloes were most numerous but cannot compete with Shorthorns in the Bluegrass region of Kentucky.

In order to avoid the concept of adequacy or deficiency, a set of terms is suggested here that are quantitative. For the traditional terms, "superhumid," "humid," "subhumid," "semihumid" or "semiarid," and "arid," substitute the terms *wet, high rainfall, mid rainfall, low rainfall,* and *dry.* These would express the purpose of classification with reference to precipitation in simple, common language. If these particular terms meet objection, then let someone bring forward others that are strictly quantitative. Likewise, the terms descriptive of the vegetation of a geographical area should specify what is present, not what is absent—"forest," "grass," "desert shrub," and so on. Forrest Shreve provided a model approach to desert vegetational nomenclature on a quantitative basis in his terms "simple stands" (1–3 species in combination), "mixed stands" (4–12 species), and "rich stands" (more than 12 species).[1]

A FOREST MAN'S REACTION TO GRASSLAND

A conspicuous example of a forest man's reaction to the grassland is to be found in the report of Captain R. B. Marcy on his expedition up the

[1] Forrest Shreve: The Desert Vegetation of North America, *Botan. Rev.*, Vol. 8, 1942, pp. 195–246; reference on p. 202.

Canadian River in 1849. The trail on the south side of the Canadian River led him across the north end of the Llano Estacado near the present Texas–New Mexico boundary line:

When we were upon the high table land, a view presented itself as boundless as the ocean. Not a tree, shrub, or any other object, either animate or inanimate, relieved the dreary monotony of the prospect; it was a vast, illimitable expanse of desert prairie—the dreaded "Llano Estacado" of New Mexico; or, in other words, the great Zahara of North America. It is a region almost as vast and trackless as the ocean—a land where no man, either savage or civilized, permanently abides; it spreads forth into a treeless, desolate waste of uninhabited solitude, which always has been, and must continue, uninhabited forever; even the savages dare not venture to cross it except at two or three places, where they know water can be found. The only herbage upon these barren plains is a very short buffalo grass, and, on account of the scarcity of water, all animals appear to shun it.[2]

Marcy calls the grassland a "desert prairie," "the great Zahara," "a treeless, desolate waste," and "barren plains" but at the end describes it as covered with buffalo grass. Two features seem to have controlled his thinking about the country he was describing: it was treeless, and it was waterless. It had moisture as well as buffalo grass, because moisture was necessary in order to have buffalo grass, but Marcy apparently wanted the evidence of running water that he could see—streams or springs.

A Practical Example of Regional Understanding

An outstanding example of practical understanding of the significance of regional differences is furnished in the address of T. C. Henry of Abilene, Kans., before the county fair of 1870.[3] Henry was not a scientist; he was a real-estate promoter with a farming background in New York State. He had gone to Alabama after the Civil War to raise cotton with freedman labor but found it impossible to make a profit on seven-cent cotton that cost 20 cents to produce. He then turned to Kansas, in 1867, and by 1870, at the age of twenty-nine, was a leading citizen in a frontier community. His ideas of regional differences were born, therefore, of practical experience in New York, Alabama, and Kansas, and probably no scientist has ever stated the fundamentals more effectively. The thing about Kansas that seems to have impressed Henry most was the presence of native grass, and it provided him with his central theme for the comparison of the three regions. In the East it was necessary to cut the trees of the forest to let in light, and

[2] R. B. Marcy: Report of Exploration and Survey of Route from Fort Smith, Arkansas, to Santa Fe, New Mexico, Made in 1849, *31st Congr., 1st Sess., House Ex. Doc. No. 45* (*Public Doc. No. 577*), p. 42.

[3] *Abilene* [*Kans.*] *Chronicle,* Nov. 10, 1870.

to dig drainage ditches "in order that the earth might bring forth grass." The first task of the forest pioneer was to prepare grass, and he might spend the greater part of a lifetime "before he could possess himself of a meadow" comparable with native Kansas grass. In the East he must cultivate and renew his field of tame grass, but in Kansas grass was the natural vegetation, which perpetuated itself.

The South was faced with the fact, "startling in its importance, that no valuable variety of grass has ever been grown there," and to this, even more than to political and social factors, he thought, were to be ascribed "the present prostration and comparative poverty of those states." Furthermore, he was convinced that until an adequate remedy for this grassless condition had been provided, even the corrections and reforms resulting from the Civil War could not assure any degree of prosperity.[4] The immediate effect of the war had been to make matters worse rather than better throughout the South in general, and "today the happiest and most flourishing section in the entire south is eastern Tennessee. The single fact that clover *is* grown there, and cotton *cannot* be, accounts for the great difference." The only other grass-growing section of the South, he pointed out, was in Texas:

> The culture and growth of grass insures a diversity of agricultural employment and occupation that otherwise cannot exist. . . . Then the greatest means of fertilizing and recuperating the soil is withheld and instead of the beautiful system of rotating crops . . . the entire attention is directed to the simplest cultivation of some one or two staples.

Henry argued that the people of Kansas must recognize that there was less rainfall in Kansas than in Ohio or New York and that Kansas could not grow rice like Carolina or corn like Illinois. He challenged the right of those states "to set up a standard of superiority." But, he continued, Kansas did grow grass and wheat and livestock better than those states, and the smaller amount of rainfall was the factor that assured this Kansas superiority; Kansas farmers should capitalize on their advantages, study nature, "adapt the crop to the soil," or "prepare the soil for the crop." He was convinced that eastern methods of farming were not suitable in Kansas, and "the sooner we recognize and acquaint ourselves with these differences and place ourselves in harmony with them, the sooner may we avail ourselves of the unequalled and exclusive opportunities our country affords." In another place he said: "Then let us stop claiming foreign advantages, and advantages too that are diametrically opposed to the real and essential ones that we do

[4] The recent introduction of the Asiatic legume kudzu seems to have met this need in the South for the first time in its history.

possess, and proceed in our own independent manner 'to work out our own salvation.'" And once again he restated his theme that the Kansas system of agriculture should be "distinct and apart—as our necessities are distinct and apart": in the differences lay the advantages that Kansas, a grassland, possessed over the eastern forest land.

Ecological Factors

No geographer or historian is adequately equipped to discuss regionalism who does not possess a fair competency in the field of ecology—either plant or animal ecology, but preferably general ecology, which includes both. And the term "ecology" itself ought to be sufficiently inclusive to embrace soil science. The ecology of soil microorganisms is as much a part of the discipline as the ecology of forest, grass, or desert plants, and of invertebrates, mammals, or other kinds of large animals. Some microbiologists hold that microorganisms show as distinctive a geographical distribution pattern as the large plants and animals. It is in connection with the study of geographical areas from the standpoint of ecology that the conventional subjective or relativistic regional terminology becomes particularly irritating.

Three of the factors that determine climate for a geographical area are moisture, temperature, and light. Additional factors of environment, for purposes of ecology, are topography and soil. The first three must be considered, not only in terms of annual quantity, but in terms of seasonal distribution and variability within each calendar year and over a series of years. Obviously, any attempt to combine all these elements into an ecological efficiency formula would become complicated, even if it were scientifically possible. A number of attempts have been made to combine some of them, but all such systems have been open to adverse criticism. Stephen B. Jones has given a competent evaluation of the Köppen system of climatic classification and others derived from it or similar to it.[5]

The simplest form of precipitation-efficiency index attempted to make allowance for evaporation.[6] Although this was an attractive and superficially reasonable procedure, it was illusory even with respect to soil moisture in a quantitative sense. Evaporation is linked with too many factors to be subjected to measurement as a practical procedure—temperature, topography, soil texture, wind, character of the vegetational cover, and water require-

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[5] S. B. Jones: Classifications of North American Climates, *Econ. Geogr.*, Vol. 8, 1932, pp. 205–208.

[6] E. N. Transeau: Forest Centers of Eastern America, *Amer. Naturalist*, Vol. 39, 1905, pp. 875–889, Fig. 6 (p. 885).

ments of plants. From the ecological point of view, precipitation efficiency becomes even more complicated because of differences among plants in seasonal water requirements and in physiological water requirements and variations in the availability to roots of soil moisture in relation to soil texture (20 per cent moisture in sand may be wet, whereas 20 per cent moisture in fine clay may be dry). Much the same kinds of questions can be asked under the head of precipitation efficiency as were asked under the head of rainfall: efficiency of what plant, topography, soil, seasonal distribution, and so on. Similar series of problems arise in the consideration of the factors of temperature, light, topography, and soil. Such efficiency and distributional indices are inaccurate, subjective, and arbitrary—fictions and illusions that are particularly deceptive because they are derived from complicated systems of mathematical calculations and scientific data that seem to invest them with a scientific certainty. Light has received too little attention. Topography and soils are often ecological determinants where rainfall, temperature, and light are uniform. Shantz's pioneer study of the ecology of the Colorado grassland pointed out the soil differences under grama, wire, and bluestem bunch grass where the other factors were constant.[7]

Of greater value, probably, than any approach by way of precipitation- and temperature-efficiency indices is the emphasis placed on variability and frequency of extremes in the systems of Russell, Kendall, Crowe, Lackey, and Thornthwaite.[8] The value of some of these systems is impaired, however, by the degree to which they are based on climatic determination in the tradition of Köppen. Too many aspects of such systems are subjective and arbitrary. The independent approaches of Crowe and Lackey are the most original, and the climatic-year concepts of Russell, Kendall, and Thornthwaite would gain immeasurably in significance if they were based on purely quantitative data.

Factors of Survival in the Desert

The greater severity of the struggle for survival in the desert as compared with areas of higher rainfall has become an accepted assumption,

[7] H. L. Shantz: Natural Vegetation as an Indicator of the Capabilities of Land for Crop Production in the Great Plains Area, *U. S. Dept. of Agric., Bur. of Plant Industry Bull. No. 201*, 1911.

[8] R. J. Russell: Climatic Years, *Geogr. Rev.*, Vol. 24, 1934, pp. 92–103 (earlier papers by Russell are cited in the footnotes); H. M. Kendall: Notes on Climatic Boundaries in the Eastern United States, *ibid.*, Vol. 25, 1935, pp. 117–124; P. R. Crowe: The Rainfall Regime of the Western Plains, *ibid.*, Vol. 26, 1936, pp. 463–484; E. E. Lackey: Annual-Variability Rainfall Maps of the Great Plains, *ibid.*, Vol. 27, 1937, pp. 665–670; C. W. Thornthwaite: Atlas of Climatic Types in the United States, 1900–1939, *U. S. Dept. of Agric. Misc. Publ. No. 421*, 1941 (earlier papers by Thornthwaite are cited in the bibliography).

almost axiomatic, though there is no clear scientific reason for such a conclusion. The limiting factors may be different in nature, but not necessarily more severe. In the desert and in low-rainfall climates, where variability is present in exaggerated form, environment may operate more directly than in higher-rainfall climates, where competition between plants becomes more decisive. The severity of the struggle for existence is different, but apparently not greater in the one than in the other, because in either place, over a long series of years, the so-called "climax formation" allows only one new plant to survive to replace each dying plant of a species, irrespective of the increase potential of the several species.[9]

The problem of survival of vegetation in the desert and in low-rainfall environments was approached in another manner by Kearney and Shantz, and later by Shantz and by Maximov.[10] Vegetation was placed in four classes: drought-escaping, drought-evading, drought-enduring, and drought-resisting. Each class, and even the individual species within each class, meets the water requirements differently. Drought-escaping plants include the ephemerals, which grow quickly when moisture is available and mature seed, and thus survive the long droughts as seed awaiting the next rainy season. Drought-evading plants restrict growth or otherwise delay exhaustion of the water supply. This group includes native plants that restrict the amount of growth above ground and are widely spaced. Among the agricultural plants, it includes most of the cereals that are suited to the lower-rainfall areas, including the sorghums. Drought-enduring plants include desert shrubs that endure long periods without moisture by shedding leaves, even some twigs, make no new growth until water is again available, and then grow rapidly. The drought-resisting plants are those that store water in roots or stems to tide them over dry periods. Shantz classed the cacti in this group, but Maximov objected because succulents avoid severe internal water deficit through "storage and slow expenditure of water" and do not possess xerophytic features such as high osmotic pressure. The conclusion that is significant is the wide variation in the physiological as well as in the structural characteristics of the kinds of plants that become adapted to the

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[9] F. B. Sumner: Some Biological Problems of Our Southwestern Deserts, *Ecology*, Vol. 6, 1925, pp. 352–371; Forrest Shreve: The Problems of the Desert, *Scientific Monthly*, Vol. 38, 1934, pp. 199–209; *idem*, The Desert Vegetation of North America (*op. cit.*).

[10] T. H. Kearney and H. L. Shantz: The Water Economy of Dry-Land Crops, *Yearbook U. S. Dept. of Agric. for 1911*, Washington, 1912, pp. 351–362; H. L. Shantz: Drought Resistance and Soil Moisture, *Ecology*, Vol. 8, 1927, pp. 145–157; N. A. Maximov: The Plant in Relation to Water: A Study of the Physiological Basis of Drought Resistance, authorized English translation, edited, with notes, by R. H. Yapp, London, 1929.

lowest-rainfall environments. Most popular preconceptions about the nature of desert plants had best be scrapped.

Maximov's work became a turning point in botanical concepts of how plants meet their water requirements. He dismissed the traditional theories of structural defense against water losses and focused attention on the properties of protoplasm and the ability to endure wilting. Ecological thought has not been fully reoriented to the new point of view, and little impression seems to have been made on the other disciplines in which these views and their modifications should be fully appreciated and integrated.

Understanding Water Requirements

To the agronomist an understanding of the water requirements of plants is essential. The morphology of the plant is not the essential mark of its adaptability as a crop for a low-rainfall region, and neither is the transpiration rate. Ability to endure wilting is important. Also, crucial to successful agriculture are the seasonal water and temperature requirements. Assurance of a winter-wheat crop has been found to depend primarily on the amount of moisture stored in the soil at planting time in the fall—in other words, the rainfall of the season preceding the harvesting of the crop. Unless extremely severe, a shortage of rainfall in the spring of the harvest year has little effect on yield.[11] But even when all moisture requirements are fully met, let one day of hot winds occur in June at pollen time or in the early stages of the formation of the kernel in the head, and the crop may be destroyed. Early maturity permits escape from, not endurance of, temperature extremes. Corn requires both moisture and high temperatures during the growing season of spring and summer. A climate of summer drought and heat destroys the corn crop. Only the sorghums can provide a grain substitute for corn in the low-rainfall grassland. They seem to possess in some degree an ability both to evade and to endure drought. A good season for winter wheat is a bad season for corn, and the reverse. Of what value is any general standard of precipitation or temperature efficiency or distribution as applied to whole geographical areas? In an ecological sense too diverse a range of vegetation grows in each area for such designations to possess much meaning.

Marginal and Submarginal

A discussion of one term suggests inclusion of others that are related in

[11] A. L. Hallsted and O. R. Mathews: Soil Moisture and Winter Wheat, With Suggestions on Abandonment, *Kansas Agric. Exper. Sta. Bull. No. 273,* 1936.

the subjective sense as reflecting the idea of deficiency. The words "marginal" and "submarginal" have been adopted into the language of land use from an economic point of view, and to them the same challenge is issued—"Marginal or submarginal for what?" Instead of measuring everything in terms of a deficiency according to the measurer's standards, a more valid hypothesis would assume that every part of the earth's surface possesses utility. Nothing is marginal or submarginal except when measured by a standard that does not fit its natural characteristics, and the mere fact of the choice of an unnatural standard predetermines that the area to which it is applied must appear as deficient.

These considerations are not a digression from the central theme of this paper. The power of custom is so strong that only by a better understanding of these ecological factors can an appreciation of the principal issues be attained. Each factor that enters as a component into the concept of climate, or into the concept of vegetation, or into the concept of region, should be treated as an independent variable. The quantity of rain that falls constitutes the moisture factor. The independent variables interact, and all together constitute the "circle of facts" for the study of any particular area of the earth's surface.

Relation to Regional Psychology

In addition to the arguments for quantitative and positively descriptive terminology as a matter of good scientific methodology, the subject possesses a practical importance as a matter of regional psychology. This is illustrated conspicuously in the Great Plains region and its transitional borderlands. The propaganda of the drought decade of the 1930's and the argument that the territory was becoming a desert branded it as a deficiency region. Many extremists even argued that the Great Plains should be abandoned, except for livestock. The widespread reaction of the younger generation, thoroughly indoctrinated in the idea of deficiency, was a feeling of frustration and defeatism. These young people became convinced that there was no future for the region, that they were victims of a ruthless geographical determinism, and that their only hope was to leave. In the intensity of the urge to escape at any cost, they generally repudiated any suggestion of possibilities of adjustment. Obviously, there can be no normal cultural stabilization in an area dominated by such a complex of psychological frustration.

It may be justly argued that nothing in this article is new, that geographers and ecologists have repeatedly rejected subjective terminology. Yet

as long as they continue to indulge in the condemned practices, the subject will call for discussion. An examination of the standard textbooks, and also of monographic literature, reveals clearly that an independent quantitative and positively descriptive terminology is not employed consistently. Much could be said also about the abuses that are associated with the social interpretations allegedly derived from geography. The issues are real, whether or not they are recognized. There is no intention here of magnifying verbalism—quite the contrary. The mere fact of giving a thing a name does not invest it with magical qualities. The British-American geologist G. W. Featherstonhaugh wrote of the concept of classification that he had no disposition "to assign any value to it beyond the facility it gives me of making myself understood."[12] To fulfill this function, however, a terminology must be founded on principles that convey accurate meanings to every reader.

The Broad Application

The focus of this article is the terminology of forest, grassland, and desert, but everything said on those areas applies in principle to other geographical areas—to the Arctic, to the tropics, and to the ocean. All possess fauna and flora normal to their characteristic conditions. As the truly global era becomes a reality, these areas and their differences acquire a new importance. They should be described according to independent standards of measurement, their fauna and flora treated as normal, and each recognized as serving a significant function in a regionally interdependent world.

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[12] G. W. Featherstonhaugh: Geological Report of an Examination Made in 1834 of the Elevated Country between the Missouri and Red Rivers, *23rd Congr., 2nd Sess., House Ex. Doc. No. 151 (Public Doc. No. 274)*, 1835, p. 12.

THE UTILITY OF PRECIPITATION-EFFECTIVENESS FORMULAS FOR PLANT ECOLOGY

FELIX K. RAWITSCHER

A NEW formula for precipitation effectiveness has recently been presented by José Setzer.[1] The fact that the effectiveness of precipitation depends on the evaporation, and this in turn on prevailing temperatures, necessitates a thorough study of the ways in which the several factors may interfere. Since Penck's first attempts, considerations of the interrelationship of the factors involved have been continually improved, and undoubtedly Setzer's suggestion regarding the greater effectiveness of temperature in the higher part of the scale is adequate to characterize the climatic situation of our country (Brazil).

Generally, as in the present case, such data are immediately used as an explanation of vegetation types. However, we cannot rely solely on such formulas if we wish to understand the regional distribution, for example, of xerophytic and hygrophytic vegetation. There are other important factors that cannot be omitted, as a closer look at Setzer's exposition will bring out:

"The towns of Pirassununga, Sorocaba, Agudos, Araçatuba, and Itapeva possess the least humid climate in the state [of São Paulo]. Their annual effective precipitation is below the critical value of 64 on the Thornthwaite scale. The natural vegetation is revealing. From Pirassununga to Mogi-Mirim, from Sorocaba to Piramboia, around Araçatuba, and between Agudos and Campos Novos there are poor lands of savanna type. Shrubs are widely scattered and low (1½ to 2½ or 3 meters when fully grown). There are many subxerophytic elements, and also some xerophytic ones" (p. 254). At this point Setzer refers to a paper by the present writer and his colleagues.[2]

The facts given by us, however, are different. The vegetation found in the regions mentioned can be called neither xerophytic nor subxerophytic; such elements as Cactaceae and Bromeliaceae are almost completely lacking. The plants that retain their foliage in the dry season are provided with broad and often delicate leaves, without heavy protection against excessive

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[1] José Setzer: A New Formula for Precipitation Effectiveness, *Geogr. Rev.*, Vol. 36, 1946, pp. 247–263.

[2] Felix Rawitscher, M. G. Ferri, and Mercedes Rachid: Profundidade dos solos e vegetação em campos cerrados do Brasil meridional, *Anais Acad. Brasileira de Ciências*, Vol. 15, 1943, pp. 267–294.

transpiration, and, what is more, they transpire nearly without restriction even in the driest hours of the driest season.[3]

The explanation for this astonishing behavior lies in the large water reserves that exist throughout the year in the deeper layers of the soil. Rock decomposition in the humid tropics is rapid and reaches to very great depths, so that the undecomposed bedrock in São Paulo State, especially in the regions referred to, is buried at 15–20 meters; overlying it are strata of sandy loam or loamy sand and the like. This phenomenon is frequent in the tropical and subtropical regions of all the continents; it creates conditions that differ widely from those known in temperate climates. Ecologically it is of the utmost importance, because where there are heavy summer rains, large water reserves can be stored in the deeper layers of the soil.

In the subhumid regions mentioned by Setzer the drought of the dry winter season penetrates the soil, as we could show, to a depth of 2 or 2½ meters. Beneath, the soil is always humid, with much water available, so that the deeper-rooted plants—and roots go down several meters, some actually reaching the water table at 18 meters—always get water. Thus it is no wonder that these plants can maintain an intensive transpiration in the dry season. Not only do they not behave like xerophytes, but if they were to be characterized ecologically, they would come nearer the swamp plants, which always have water available to their roots. Only in this case the "swamp" is subterranean, separated from the surface by 1 to 2½ meters of temporarily dry layers.

From this we can see within what limits precipitation-effectiveness formulas can be used. If the soil layer were only 2 meters thick, all the available water would be lost; there would exist a real drought for all the plants, and whatever vegetation might subsist in the dry period would necessarily show xerophytic characters. However, this is not at all the case.

Thus we must recognize the influence of other factors than the purely climatic ones; for instance, the depth of soil and the existence or nonexistence of water reserves. These factors are very often overlooked in phytoecological descriptions, simply because the botanist, especially the traveling explorer, does not know exactly what conditions exist below the soil surface.

But there are other limitations to the applicability of climatological data in explaining the distribution of vegetation types: we must consider the human influence. This, too, we see well illustrated in Setzer's exposition. He continues: "In these subhumid areas sandy sediments produce infertile

[3] M. G. Ferri: Transpiração de plantas permanentes dos "Cerrados," *Univ. de São Paulo, Bol. Faculdade de Filos., Ciências e Letras, Botânica No. 4*, 1944, pp. 155–224.

soils. The yearly burning of all vegetation, repeated through several decades, has lowered the amount of organic matter" (*loc. cit.*).

In the first quotation the existence of shrubs "widely scattered and low (1½ to 2½ or 3 meters)" was related to the dryness of the climate. Then we read that the regions referred to are burned yearly. What type of vegetation are we to expect, in either dry climate or humid, where burning goes on year after year? Besides, as in every other country where there is lack of firewood, cutting the taller shrubs is customary. Pasturing is another handicap to the re-formation of the real climax; and finally, certain shrubs, such as the common *Stryphnodendron barbatimao* of the *campos cerrados*, are widely harvested for their tannin.

Thus the present vegetation of these regions does not at all correspond to the original climax vegetation, which would exist without human interference. It must be considered a subclimax, probably a "fireclimax," that immigrated into São Paulo State after devastation of the virgin forest had opened the way. The real centers of development of this vegetation, where it constitutes the true climax and the real expression of the climatological conditions, certainly lie much more to the north and northeast in the drier parts of Brazil.

We see, then, that climatological data on precipitation effectiveness are not sufficient alone to explain the distribution of xerophytic and hygrophytic vegetation; they must be accompanied by observations on water storage in the soil and by considerations of possible human interference.

THE HOUSES OF THE CHINESE

J. E. SPENCER

Les relations des voyageurs sont d'ordinaire bien pauvres en détails précis sur l'habitation en Chine. Cependant son étude serait singulièrement attachante. Le peu que nous savons nous montre très forte l'influence des facteurs géographiques. Mais il nous révèle d'autre part l'action, singulièrement profonde dans cette nation, des faits historiques et sociaux, des traditions qui peuvent maintenir un type de peuplement et de construction, ou le propager loin de la région où il a pris naissance.[1]

THESE words on the habitation in China are endorsed: I know of very few studies of Chinese house types, and the literature on domestic architecture, aside from that of palaces and other public buildings, is relatively scant. Yet the subject is engrossing. It is one in which I have been interested for several years, and in this paper I attempt to set down some general preliminary observations on Chinese house types. In most writings in English on China, including some by Chinese, architecture and the construction of domestic buildings are generalized into a relatively uniform "Chinese" pattern, a single simplified style somewhat at variance with the facts.[2] The buildings considered here are the private homes of the middle and lower classes of the farm, the village, and the city. The formal, complex architecture of Chinese public buildings and gardens is not included, or the far from typical artistic creations of the very wealthy, for these have been dealt with repeatedly.[3] Houseboats and other specialized habitational units are also ruled out in the interest of brevity, even though used by large numbers of people and significant as culture items. The preliminary nature of this paper should be emphasized: many of the opinions expressed require detailed checking by field observation in all parts of China and thorough research in Chinese literature.

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[1] Jules Sion: L'habitation en Chine, *in* Recueil de travaux offert à M. Jovan Cvijić, Belgrade 1924, pp. 39–46; reference on p. 39.

[2] See, for example, Ernst Boerschmann: Chinesische Architektur, 2 vols., 1925; A. F. Legendre: Modern Chinese Civilization, translated from the French by E. M. Jones, New York and London [1929?]; O. Sirén: A History of Early Chinese Art (4 vols., London, 1929–1930), Vol. 4, 1930; the same: Architecture, *in* Romance of Chinese Art [reprint of Encyclopædia Britannica articles], 1936.

Cressey points out that there are many kinds of houses in China in giving a brief description of representative features in the north (G. B. Cressey: Chinese Homes and Home Sites, *Home Geogr. Monthly*, Vol. 2, No. 3, 1932, pp. 31–36).

[3] George Soulie de Morant: A History of Chinese Art, translated by G. C. Wheeler, London, 1931; Dorothy Graham: Chinese Gardens, New York, 1938; Henry Inn: Chinese Houses and Gardens, edited by S. C. Lee, Honolulu, 1940; D. G. Mirams: A Brief History of Chinese Architecture, London, 1941. Even Rudolf Kelling in "Das chinesische Wohnhaus" (*Mitt. Deutsch. Gesell. für Natur- und Völkerkunde Ostasiens*, Suppl. Vol. 13, Tokyo, 1935; Part 2 and the [separate] Appendix, "Bauwörterbuch," are by Kelling and Bruno Schindler) is more concerned with the architecture of the wealthy than with the common house. His book and Inn's are the two best volumes on Chinese domestic architecture.

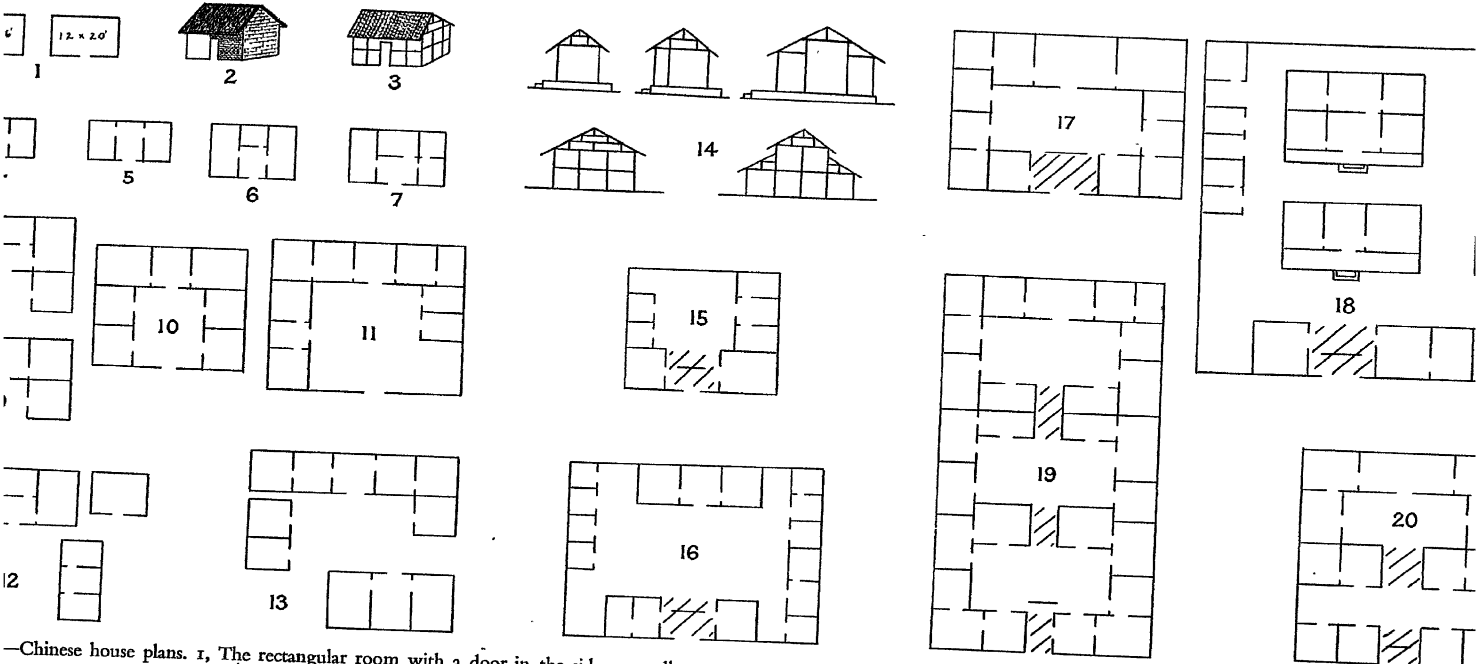
Fundamentals of Chinese Building

In Chinese construction the roof usually rests on a skeleton of wooden posts set up independently of the walls. There is a fairly elaborate method of joining together the vertical pillars, struts, plates, and main rafters to hold the skeleton upright. The posts preferably rest on stone bases. Originally these were merely waterworn boulders, but today they are frequently conventional cut-stone blocks of several patterns. The walls are relatively weak curtain walls rather than the stalwart "bearing walls" employed in Occidental construction.[4] In this respect our modern steel skyscraper has departed from the older Occidental tradition to employ a technique long used in China. The Japanese have carried the curtain-wall principle even further in their movable-panel walls. It is too much, however, to say that the Chinese always use skeleton and curtain-wall construction; for one of several factors may cause departure from the normal procedure.

Private dwellings almost never incorporate other than straight-line construction, and walls normally meet at right angles. Bay windows, offset window seats, and rounded or irregular floor plans are not a part of domestic architecture. This is not true of garden architecture, in which walls, paths and walks, pools and flower beds, are laid out in any way possible to avoid rigidity. It also is not true of formal building, in which curved lines are frequently employed. Multiplicity of gables, random nooks, and other special features of Occidental buildings are noticeably absent from Chinese construction. The primary building unit is a rectangular room roofed with an ordinary gable and straight-line ridgepole. The roof may be symmetrical, or one set of rafters may be longer than the other, with the short set to the front. If a larger floor space is desired within the one unit, a supplementary hip roof is set below either gable, displacing the lower part of the gable wall. Chinese building proceeds by duplication of this basic unit, either for separate structures or for integrated units. In close village and town settlement, where frontages are at a premium, a deeper unit results from a higher ridgepole and longer, sloping roof surfaces.

Prominent in many descriptions is the picture of the courtyard surrounded by buildings on all four sides, or on three sides with the fourth closed by a wall and gate. Admittedly the enclosed courtyard is the ideal to which Chinese builders aspire, but the full plan is not achieved everywhere. It seems to be a fundamental rural type which probably occurs all over China today but which is more commonly found in the north and northwest. It may not be a very old type, but one evolved out of a need for a

[4] H. G. Creel: The Birth of China, New York, 1937, pp. 61–68.



—Chinese house plans. 1, The rectangular room with a door in the side, centrally the fundamental pattern of Chinese building; any windows are on the same side as ', The thatch-roofed mud building is wide spread. Right-end wall of packed earth, narked by the small holes of the form cross-members; front right wall of plain adobe front wall mud plastered. 3, Tile roof on white paneled wall is characteristically e, but is found throughout southern China. 4, 5, 6, 7, Simple variations of room of a single building unit. 8, 9, 10, 11, Evolution of the closed form of scattered uilding in the L, U and closed U types. 12, 13, Variations of the isolated farmstead l a threshing floor. 14, End views of several manners of joining skeletons to support roofs; the upper three units on terraces; the three pillared pattern is used when a verar fronts the structure (plan 18). 15, 16, 17, Variations of a village building pattern of the b sort. Ruling marks covered passage ways and entrances; the transverse line in the entranc the "spirit wall" which maintains privacy of the courtyard when the main gate is open. 18, of China's oldest building plans, using transverse units for the main rooms, subordinate ro along either side. 19, 20, Variations of the urban multi-court building pattern. Plans 1 and 4 are scattered farmstead types. Plans 1, 4–7, 10, 11, 15–17 are village, small town or city ty Plans 18–20 are primarily urban types, though occasionally a rich family with urban conn tions will build a variation of 18 in a home village.

protected retreat. The surrounded courtyard requires modification when employed in close settlements, and several functional modifications exist.

Another basic form of construction is the series of rectangular halls set transversely across a yard with interspaced courts and with minor buildings running longitudinally along either side margin, the whole enclosed by a wall.[5] This is the almost universal plan of construction in palaces, temples, government buildings of the older pattern, and private homes of wealthy families. Similar forms, on reduced proportions, are employed by many middle-class families. This type of layout may possibly be the oldest true "Chinese" style.

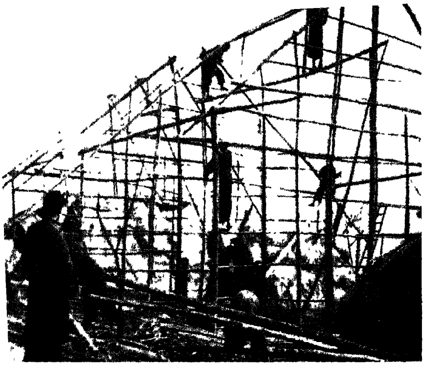
The classic descriptions mention a south frontage for buildings, and location on a precise site in accordance with the dictates of a specially hired geomancer. This, again, may have been the ideal situation in historical China, but it must be added that a Chinese geomancer usually was somewhat of a realist, aware that not every building could face south either in close settlements or in the open countryside. I have never seen a region with all its scattered houses facing south, or a village with houses only on the north side of an east-west street.

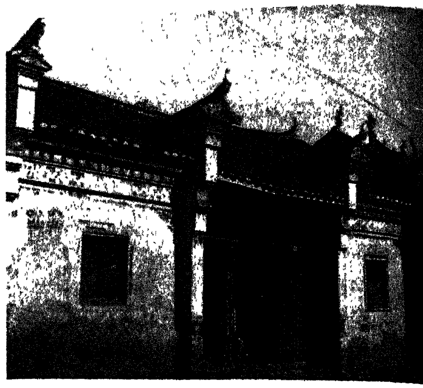
A rule that is seldom violated, however, is that the rear, long wall of a simple rectangular unit is solid, unbroken by doors or windows. The tendency to build rooms around a court focuses upon the court, for both light and entry. In isolated, rural buildings entry to the compound through a single gate or door permits each farmstead to be self-contained and easily defended. Even in close settlements units back up against each other, with common blank walls, an arrangement that permits dense packing of population into small areas. It further permits the privacy that every Chinese family cherishes.

It is normal, but not exclusively the rule, for rural and farm buildings to be single-storied. Village, small-town, and marginal urban buildings are a story and a half or two stories. Central urban buildings frequently are two-storied in the native Chinese scene. Only occasionally have special regional conditions carried Chinese buildings to more than two stories. Modern urban architecture is expanding skyward through need for space for street widening in old, established cities, and through Occidental influence on design and on structural materials.

When possible, a house is set on a platform or a raised foundation. This is usually ringed with trimmed stone to give a firm and lasting foundation structure. Often on an isolated site a large platform is built that will accom-

[5] Sirén, A History of Early Chinese Art (*op. cit.*), Vol. 4, p. 14.





'G. 2—A thatch-and-matting house frame in initial of construction, western Hupeh, 1935. Trimmed fir ;s support the four corners; elsewhere bamboo is used.

G. 3—Unfinished construction of multi-unit wartime : housing in central Kweichow, 1939. Walls of pounded roof skeleton of bamboo; thatch will be rice straw.

3. 4—Construction of pounded earth wall around multi-unit, wartime refugee building, central Kwei- 1939. Earth is tramped under foot and pounded with ı tamper until frame is full.

Fig. 5—House front in small town in southern Hupeh, 1933. Fired brick with whitewashed plaster veneer, tile roof with moderate decorations, faded murals under the eaves.

Fig. 6—Lower-class village houses, western Szechwan, 1938. Each unit fronts directly on street but often has small yard enclosed by laced bamboo fence at rear or side. Note open half doors on nearest house.

Fig. 7—Urban construction in a county-seat town of central Szechwan, 1937. Shop fronts and roof brackets finished in black lacquer, plaster panels whitewashed, tile roofs.

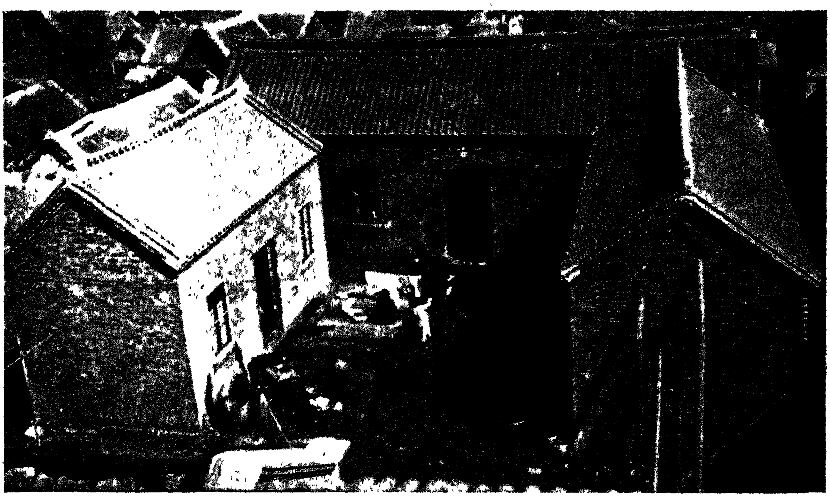


FIG. 8—Scattered single-unit adobe and thatch houses of a village in central Hupeh, 1933.

FIG. 9—Large single-family urban house built around courtyard, northern Anhwei, 1933. Party wall closes the "U" of the yard just below camera in immediate foreground. Construction of gray half-fired brick and tile.

FIG. 10—Roof view from city wall of an old district city of northwest Hupeh, 1934. Simply decorated tile roofs indicate individual units and separate courtyards.

modate all eventual building units. In some parts of China the platform extends considerably forward of the house. Not all small houses have the platform, and most homes of the poor omit it. In some buildings it may be seen as an open but roofed veranda across the front of a house, but only in formal building or in houses of the wealthy is the true veranda a common feature.

Roofs

In the earlier writings on China it was customary to diagnose the curved roof as an evolution out of the tents in which the mythical but nomadic ancestors of the Chinese once lived. More recently it has been recognized that the Chinese have been an agricultural people far too long for this to be true. Earlier Chinese buildings had straight-line roofs, and the curvature came relatively late into common use, possibly from South China.[6] It has always been restricted to public buildings or those of the wealthy. Another probable error in early writing is the inference that the rounded Chinese tile was derived from bamboo.

Complete uniformity in building materials throughout a large region is not to be expected, but in roofing materials Chinese buildings present a striking example of the relative dominance of two types of material for ordinary use. Half-burnt gray tile and straw thatch are so common as to seem universal. The tiles are made locally in every district in China, almost to a single size and pattern. They are brittle and breakable, but easily procured. In the north, thatch is made of wheat straw, millet, or kaoliang stalks; in the more southern rice-growing areas these are replaced by rice straw or tall wild grasses. Whether thatch or tile is used seems to depend on local prices, supply, and prestige.

But despite the spread of these two roofing mediums, the Chinese are acquainted with several more.[7] Bamboo, split in half and placed lengthwise downslope, alternately concave and convex, makes a good and relatively secure roof when the right kind is available. If it is not, several layers of lime cement, spread thinly and allowed to dry between applications, may be placed above the bamboo. Bamboo roofs are not popular and are neither common nor widespread, being used out of some local necessity only.

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[6] *Ibid.*, pp. 20–21 and 27; Inn, *op. cit.*, p. 32; C. W. Bishop: Origin of the Far Eastern Civilizations, *Smithsonian Instn. War Background Studies No. 1*, 1942, p. 32.

[7] Descriptions of various types of Chinese houses and their individual features are to be found in the abundant literature on China in West European languages. Descriptions in Chinese include several articles in the *Journal of the Geographical Society of China*. Many of the observations and opinions expressed in this article are the result of my own observations over a number of years.

Split-bamboo or reed matting often provides the roofing, neither rainproof nor windproof, for the huts and mat sheds of the poorest classes. In restricted areas of South China palm-leaf roofs sometimes replace rice-straw thatches. In South China and along the Tibetan border bark roofs are occasionally seen, the slabs placed alternately concave and convex. Pine board or shingle roofs, often held down by stones, are common all along the Tibetan border. Their origin is unknown at present, but they are probably neither Chinese nor Tibetan. Stone roofs are used in many parts of China where local outcrops of platy limestone, shale, or slate are found. Beaten-mud surfacing over a branch or reed layer is the normal material of the flat roofs of much of Northwest China.

Modern urban roofing materials are becoming cosmopolitan in nature. Heavy, full-burnt tile of Occidental shape, color, and placement is one of the most commonly used of the newer roofing materials on more pretentious buildings. Other new mediums are appearing but are still largely restricted to metropolitan commercial and industrial usage.

Walls

Perhaps most frequent in the farm villages and scattered homesteads all over China are walls of sun-dried bricks. They have invaded the humid parts of South China, are found in the highlands of the Tibetan border and on the Yunnan-Burma border, and have spread far down into French Indochina. In this century at least, the bricks are often poorly made of chance clayey earth hurriedly mixed and formed, or even simply cut out from the drying bed of a rice field with no treatment other than further drying. If a roof leaks severely, in consequence of an unusual downpour or neglect, whole walls may tumble over. Floods may reach above foundations and melt houses down overnight. If the house skeleton is in good shape, it will remain standing, thus permitting restoration of the walls when the storm or flood has passed. Brick sizes vary somewhat, but thick, massive walls are made of sun-dried bricks. The usual North China practice is to leave them bare of any surface plaster. Central China often covers the outer surface with a thick layer of simple mud plaster, which gives the wall both a smoother finish and less opportunity for rainwash. South China and Szechwan frequently add a final coat of whitewash.

The pounded-earth method of building walls, common in an earlier day, is still used almost everywhere in China. Formerly clay was so well puddled, and so thoroughly tamped when put into the forms, that many

vestiges of ancient buildings remain centuries later.[8] In the present age labor is too costly and the job too often hurried, and the results are therefore inferior. During the recent Sino-Japanese War, influx of refugees, scarcity of materials, and inflationary costs in West China caused a wide revival of this type of building, and I then saw house walls built one day that had fallen down when the workmen arrived next morning.

Kweichow has developed a local method of using sun-dried bricks and tamped earth to produce a durable structure. Wide overhanging eaves set on rather low walls give an unusual degree of protection from rainwash, and the outer wall is plastered with lime cement and whitewashed.

These wall mediums require massive construction, with the minimum number of breaks in the lower part of the walls. In a simple building there is usually but one door, and windows are few or entirely lacking. When windows are installed, they tend to be narrow and to be placed in the front wall. A common practice in Central and South China villages when brick or earth forms are used is to construct the whole front wall of a house of wood, so that ample door and window space can be provided without consideration of the weight of the upper wall.

From Central China southward bamboo wattle and plaster frequently enter into wall construction. Split bamboo is interlaced, at a 90° angle, and the ends set in grooves prepared in the skeleton. Plaster can be applied to either side to give an airtight, though light and flimsy, wall. Skeleton timbers remain exposed both inside and out. Szechwan perhaps uses this technique most effectively, where the whitewashed, thatched houses are extremely attractive and remind a Briton of "old English, half timbered."[9]

Bamboo or reed matting is often used in place of the split-bamboo lath. In Central and South China bamboo frequently replaces wooden timbers in the skeleton. Where timbers are mortised together, bamboo is usually laced with thongs of split bamboo.

Matting of split bamboo or reeds may be used over a laced-together skeleton without further covering. There are many temporary buildings of this nature, on river foreshores in low-water season, on temporary fair sites, as the huts of the poor, or for fire victims in the first quick rebuilding. In the Sunwei district, near Canton, palm fronds are used for both the walls

8 H. G. Creel: Studies in Early Chinese Culture, First Series (Amer. Council of Learned Societies Studies in Chinese and Related Civilizations, No. 3), Baltimore, 1937, pp. 177–182; C. W. Bishop: An Ancient Chinese Capital: Earthworks at Old Ch'ang-an, *Ann. Rept. Smithsonian Instn. for 1938*, Washington, 1939, pp. 569–578; reference on p. 570.

9 H. A. Franck (Roving through Southern China, New York and London, 1925, pp. 142–143) remarks on similar architecture in Kiangsi as "mildly reminiscent" of Nuremberg, Germany.

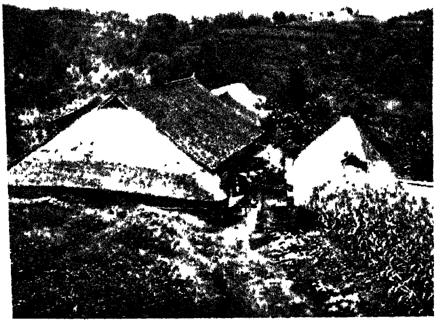
and the roofs of light-weight houses with walls built of sea shells set in a lime matrix. Occasionally in South China one sees an inferior house built with brush walls. Stone is almost always used for foundations when it can be had, but it is not widely accepted for wall construction, though it is known in all mountainous areas. It is not at all clear why this discrimination should be so persistent, but it is of long standing.[10]

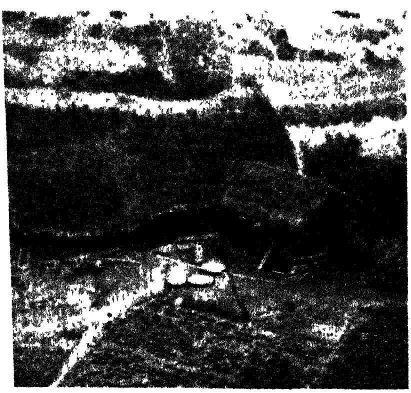
Gray half-fired brick has become, in recent years, the most popular building material for better-class urban buildings, which take on varying degrees of Occidental form, plan, design, or constructional technique. Half-fired bricks are not new in China, but the shape, size, and method of laying have changed in recent decades. The old type was more nearly a tile about five by six inches and about an inch thick. These were set to form hollow squares, and the spaces were filled with rubble. Such a wall deteriorates progressively and with greater rapidity than a solid wall of larger bricks. The modern brick houses practically always have tile roofs, more numerous windows, of glass rather than paper, good floors, and other appurtenances. Akin to modern brick forms are the buildings finished in rough stucco, which is an occasionally used importation from the Occident.

Walls are sometimes built entirely of wooden boards, though this medium is not really popular with the Chinese. To what degree the timber scarcity enters into the situation it is difficult to say, but there are numerous occasions when wood could be used and is not. Historically, wood scarcity should not have been a factor except in restricted parts of the North China loess lands and the littoral of the North China Plain, but this is where the "Chinese" types of houses originated.

In compact settlements a wall is often made to serve two purposes. It may separate two houses, in which case it is termed a "party wall." Party walls are very common in Central and South China settlements, and often roofs, particularly when thatched, are so integrated as to give a continuous surface. In tightly packed cities party walls may be built at regular intervals as firebreaks. Sometimes a number of units, built together, have side walls that are in reality only thin partitions. Where construction is not simultaneous or contemporary, the wall of one unit may be used by another without being a true party wall. This often occurs in open urban or village construction, when a neighbor's wall is made to serve as the closing element.

[10] Sirén (A History of Early Chinese Art [*op. cit.*], Vol. 4, pp. 35–36) says that the oldest known treatise on Chinese architecture, the Sung-dynasty "Ying-tsao Fa-shih (The Method of Architecture)," A.D. 1103, only casually mentions stone and has not a single reference to brick. This however is not correct; the book contains "specific rules for building all kinds of stone, wood, tile, and brick structures" (L. Carrington Goodrich: A Short History of the Chinese People, New York, 1943, p. 153).





:. 11—Tea houses at a rest stop on a secondary road, estern Szechwan, 1938. Main unit at left has tiled .pped roof addition is thatched with rice straw.

:. 12—Single-unit house, eastern Kweichow, 1939. :d roof with walls of brush, bound into thick bundles tand on end in a row around house skeleton.

. 13—Single-unit house in eastern Kweichow, 1939. alls of adobe brick with natural-color plaster finish; :ep, with deep overhang; steep hip-roofed lean-to fill in each end.

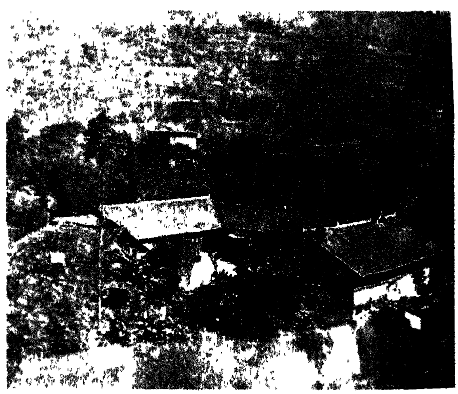


FIG. 14—Slate-roofed roadside shop, southeastern Kweichow, 1939. Note the crude stone unit with poor thatch roof at right.

FIG. 15—Home of a well-to-do landlord farmer, central Szechwan, 1937. Entrance to courtyard is at left corner of building. Plaster panels above and below an oiled wood strip of panel. Roof is of tile. This type of house contains ten to twenty rooms, sometimes two courtyards.

FIG. 16—Farmhouse with enclosed threshing floor, western Szechwan, 1938. Plaster panels, tile roof.

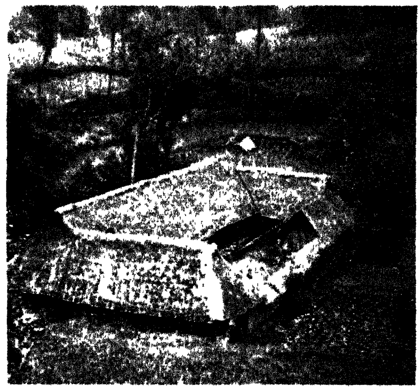


FIG. 17—Rural farmhouse of a moderately prosperous family, western Szechwan, 1938. House on a slope, behind a screen of bamboo. Several units are roughly grouped around a threshing floor, but no wall surrounds the house.

FIG. 18—"U" shaped adobe brick farmhouse backed by bamboo clumps, central Szechwan, 1937.

FIG. 19—Some ten separate units scattered around the central building at left make up this farmhouse of a family numbering about twenty-five residents, western Szechwan, 1938. All units of adobe brick and straw thatch.

FIG. 20—Flailing beans on threshing floor of a farmhouse composed of single units as indicated in plan number 13 (Fig. 1). Note the low stone platform on which main unit is set; roof of straw thatch with ridge line of tile.

FIG. 21—Fully enclosed farmhouse, western Szechwan, 1938. Low adobe wall, thatch covered for rain protection, closes off the courtyard. Entry gate at lower corner.

FIG. 22—Fully enclosed courtyard of the rural home of a city merchant, western Hupeh, 1936. Gray, half-fired brick, with whitewash finish; tile roof with lime ridge lines.

Floors and Floor Plans

Five kinds of flooring material are ordinarily in use. Packed earth greatly outnumbers the others in all parts of China. Occasionally a floor is covered with lime cement, though this is more common in courtyards and gardens. Brick floors are sometimes found in North China. Wooden floors are frequently used in better-class houses, are the rule in pile dwellings, and may be found on the ground floors of modern urban brick and stucco houses. Modern urban houses often use marble chips, parquet cement, or tile on the ground floor. A special case is the split-bamboo house with a bamboo or rattan floor raised a foot or more off the ground that occurs on Hainan Island and in the Yunnan-Burma border country.

There is no apparent uniformity of floor plan in either isolated or compact-settlement building. Most structures that have even a partial inner court are built according to somewhat similar plans, and so are houses consisting of rectangular units inside a wall. However, mature floor plans are in the minority, if for no other reason than economic restrictions. The basic unit of Chinese building being a rectangular room, it may remain single and whole in very poor families, or it may be divided into two, three, or more parts by partitions from front to rear wall. In a large rectangle, cross partitions, running with the ridgepole, may further divide the floor space. When possible, the front door, set in one side but never in the end, opens into a section reserved as entrance hall, common room, dining room, and guest hall; the remaining rooms are reserved for family use only. Many houses never grow beyond the single rectangle. In some farmhouses an addition forms an L; others achieve a second wing, forming a U, which can be closed by a wall to make a protected unit. In compact settlement, where the closed U is impossible, houses may expand upward to a second story or, if space is available, rearward in a series of alternating room and court units. If space was originally provided within an enclosing wall, a series of rectangular units, intervening courts, and secondary buildings are built on the general plan of a temple.

Detached kitchens, servants' quarters, gatehouses, storage rooms, and lavatories are normal in larger establishments; in smaller houses any or all of the auxiliary units may be lacking. Poor provision for each is the rule, with the exception of the gatehouse. Kitchen and lavatory, always primitive except in truly Occidentalized buildings, in juxtaposition are a common and disturbing aspect of domestic building. The problem of insulating a kitchen stove burning wood, charcoal, or coal in a small and inflammable building is serious, perennially leading to disaster. In farmhouses all over

China it is common for the domestic animals and fowls to share some part of the buildings, and for one room or more to be used for crop and food storage.

As a result of variation of the urban floor plan of alternating court and room units, Chinese settlements contrast strongly with American suburban zones in the respect that buildings more nearly cover the ground and there is little free earth, no front lawns, and few back-yard gardens. Sometimes the upper-class courtyard will display a compact bit of rock gardening and a tree or a bamboo clump, but many a court has all its little greenery in rows of pots. Most village and small-town shops are also the residences of their operators. Without resorting to multiple stories, therefore, the Chinese city packs a large population into a relatively small space.

In the view of some writers the ancestral hall—the single room, or the portion thereof, devoted to an altar, sculptured gods, ancestral tablets, memorial scrolls, and other worship materials—is the central unit in a floor plan. Where affluence permits, this is realized; when smaller means cannot provide a separate ancestral hall, such space use seldom dominates a floor plan, and lack of space may go so far as to limit worship materials to the rear half of a centrally placed all-purpose table, along with the wall space above the table.

Minor Architectural Features

There are a number of minor features of Chinese houses that form significant characteristics of architecture: latticed windows and walls, half doors for daytime use, roof decks, awnings, lacquer wood finishes, murals, materials substituting for glass in windows, carving on rafter ends and supporting brackets, ridgepole ornamentation, gatehouse-entry decoration, gable-wall devices, and many more. Often it is the minor features that provide the regional distinctions that catch the eye of the traveler interested in houses. A few examples may be noted. The Chinese door normally consists of two wings, swinging on top and bottom pivot-and-socket hinges. Except in mat huts the door is always of solid wood, and in small houses with few windows it must be left open during the daytime to admit light. The half door is a device for admitting light but barring the entryway. It is built and hung like the main door and, within my experience, is always supplementary and not merely the lower half of the main door; that is, the house really has a door and a half. It is most frequently used in the small house fronting directly on a street, having neither courtyard nor enough windows. Its distribution is irregular but wide, and it is prob-

ably a compact-settlement feature. In some Szechwan villages nearly every house has such a door, whereas near-by villages may have almost none. In South China most urban houses possess a flat wooden roof deck reached by a narrow inside stairway. The decks are used for drying laundry or getting a breath of air on hot summer evenings. They are never roofed and are seldom used as sleeping porches because of the prevailing notion that it is unhealthful to sleep in the open. Such decks reach into the Yangtze Valley but are not found everywhere in South China and are not seen in West China. Their distributional limits appear uncertain, and I would hazard the guess that their occurrence is related to overcrowding in urban settlements, as a substitute for courtyards. The upper parts of gable walls, at the ends of a house, are differently treated in different parts of China. Narrow gable murals in black and white or in colors are found in various parts of Central and South China, and it is likely that there are several localizations of this kind. The most distinctive to come to my notice are those of western Yunnan. The better-class houses around Tali have large black-and-white arabesques and small, pointed windows occupying the whole upper portion of the gable wall.[11] Farther north in western Yunnan a variety of fresco patterns appear.

Regional Distribution

At this stage of our knowledge about China, and in the absence of an extensive Chinese literature on the subject, no accurate picture can be drawn of the regional distribution of the several kinds of domestic architecture. Certain opinions set down here are only tentative. The use of whitewash as a common exterior decorative or preservative element appears to come out of South China, reaching into the Yangtze Valley and West China. In North China all kinds of walls are normally left unsurfaced and raw-earth yellow in color. Along with whitewash would seem to go the further decorative attributes such as murals, plaster designs, and roof ornamentation. Naturally there are many regional distinctions in the use of bamboo, which is another South China material having a variable and not well-identified northern extension. It becomes an imported product on the northern edges of the Yangtze drainage basin and certainly is not widely used in building in far North China. The pile dwelling would seem to be not originally Chinese, but associated with a humid-land culture of Southeast Asia. It is common today in the lake country of the Yangtze

[11] Perhaps attributable to Moslem influence says C. P. Fitzgerald: The Tower of Five Glories, A Study of the Min Chia of Ta Li, Yunnan, London, 1941. See the photograph facing p. 46.

delta, is almost the invariable rule in parts of the tall grasslands and fenlands of central Hupeh, is scattered along the south-coast littoral, and is variably distributed elsewhere in South China. It may well have been widespread in the area southward from the Yangtze Valley at the time Chinese culture spread southward.

Wooden houses present an interesting problem in distribution and relationship. They are found throughout the Chinese-Tibetan border country, from Yunnan northward into Kansu, and they are occasionally seen in Kweichow. There seems to be a pattern of all-wooden construction employing logs, hewn timbers, and planks in which elaborate carving is sometimes found and is sometimes absent. Perhaps Chinese wood carving was borrowed from the carpenters of this region at an early date. There is also a pattern in which upper stories only are built of timbers and planks, with considerable carving, the lower stories being built of untrimmed stone. Board, shingle, bark, and, sometimes, thatch roofs go with the first pattern; the flat mud-surfaced roof goes with the second. Variably associated with these patterns is a third, an all-stone, flat-roofed house normally associated with Tibet. Chinese houses of several kinds are also found throughout the border country today. Within this belt of country live Chinese, non-Chinese tribes of various racial and ethnic relationships, and Tibetans. All patterns of houses seem to be occupied today by all kinds of people, with the probable reservation that Tibetans only infrequently adopt the external patterns of Chinese architecture. The Chinese readily adopt non-Chinese architecture when infiltrating into the Tibetan border country and build several kinds of houses there today.[12] Although in their own environment the Chinese, as has been indicated, do use wood in various ways, they do not seem to possess their own all-log-and-hewn-timber house pattern. One writer attributes the wooden houses to the peoples of Tibeto-Burman racial stock.[13] It is clear that some of the non-Chinese tribes, such as the Min Chia of the Tali area in Yunnan, have lost much of their indigenous culture, and that some of them are now indistinguishable from Chinese in certain traits, including architecture.

The dwellings of the inhabitants of the old North China culture hearth were of the pit-house variety.[14] Artificial caves are found in Shansi, and something that appears to resemble the ancient pit house has been described

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[12] For an example see R. B. Ekvall: Cultural Relations on the Kansu-Tibetan Border, *Univ. of Chicago Publs. in Anthropol., Occas. Papers No. 1*, 1939, p. 45.

[13] Gerald Reitlinger: South of the Clouds, London, 1939, pp. 108–109.

[14] Creel, The Birth of China (*op. cit.*), pp. 60–61.

from Shantung.[15] Related to both is the loess cave of North China.[16] The older method of vertical digging is still used today, but the newer and more easily utilized horizontal caves are commoner.[17] Whether the distribution of the old pit dwelling, and of the cave dwelling, is coincident with that of loess is not at all clear from the literature on North China. Certainly the pit house and the cave must always have been restricted to localities having deep water tables or low rainfall totals. Caves have been excavated in locally outcropping sandstone within the area of loess distribution. Related to the horizontal cave house is the long structure, many-roomed and windowless, with a vaulted front and flat balustraded roof placed against a loess cliff. Complete villages are built in this manner in Shansi and Shensi.

The k'ang, or heated brick bed platform, of North China provokes several questions. Was the k'ang associated with pit dwellings, and with caves, or does its evolution date from the growth of surface-built houses? It is widely distributed today throughout North and Northwest China, but only rarely is it seen within, or south of, the Yangtze Valley, and in most such occurrences the platform is simply a dummy, built for its raised position rather than for its heating potential.

The Chinese do seem to build with stone upon occasion, even if it is not a preferred material. Whole towns and villages built of stone are found in North China in the Tai-hang Mountains, which separate Hopei and Shansi. Stone villages appear in Shensi, in Szechwan, in Kweichow, and in Yunnan, though in the last two provinces there is always the possibility of the non-Chinese origin. With stone buildings often go slate or shale roofs. Dressed stone is occasionally used for house walls—around Tali, Yunnan, for example, and in parts of Szechwan—though it is more commonly reserved for the platform foundation. In some areas, such as the Tai-

[15] H. A. Franck (Wandering in Northern China, New York and London, 1923) notes that not a few people lived in "holes cut in the ground and roofed over with sticks, straw, and mud, with a crude ladder or notched pole by which we descended through a small opening to the dark interior" (p. 293).

[16] M. L. Fuller and F. G. Clapp: Loess and Rock Dwellings of Shensi, China, *Geogr. Rev.*, Vol. 14, 1924, pp. 215–226.

[17] Sir Alexander Hosie (On the Trail of the Opium Poppy, 2 vols., London, 1914) describes the earlier cave thus: "There is the underground cave-dwelling, where a large, deep hole is dug in the ground (it may be in a flat field), and from the bottom of the hole, which is reached by a steep incline, rooms are excavated underground. Whole families, and even villages, thus live under the surface, and the only indication of their existence is a low mud wall built round the mouth of the hole" (Vol. 1, p. 152). Clark and Sowerby (R. S. Clark and A. de C. Sowerby: Through Shên-kan, edited by C. H. Chepmell, London and Leipzig, 1912) state: "Each dwelling would consist of one large square pit, twenty to thirty feet deep, and forming the courtyard, from which opened deep cave-rooms, occupied by the members of the family and their live stock. The courtyards were reached by long and gently sloping shafts, fitted at their lower ends with stout wooden doors" (p. 36).

hang Mountain country, no real timber has been available for centuries, and this may have contributed to changing building techniques in an area abundantly supplied with stone. Elsewhere causal relationships are not so easily established; indeed, the regional distribution of stone architecture is only imperfectly reported.

There is regional distinction in roofs. South China roofs display greater curvature and a greater variety and frequency of decoration than the roofs of North China. Both curvature and decoration go with tile rather than with thatch. The flat mud roof of Northwest China does not permit much variation in its construction. The distribution of the flat roof is rather peculiar. Although its limits are not clear, it seems restricted for the most part to the arid landscapes of Northwest China. But in the Tibetan border country it is associated with stone and stone-and-timber construction, and it is found even in humid southern Yunnan among non-Chinese groups. Why should it be confined in Chinese use to the truly arid lands when non-Chinese and Tibetans employ it successfully in relatively humid areas? The only answer that comes readily to mind is that the flat roof is not Chinese at all, but a trait borrowed from other peoples of Central Asia. In the Tibetan border country it may have been originally Tibetan, carried out of the higher lands by some of the Tibeto-Burman peoples, or at least by non-Chinese. At any rate, in eastern Shansi localities can be found in which stone buildings, loess caves, sun-dried brick and tile, sun-dried brick and thatch, and sun-dried brick and flat mud roof occur almost side by side. This multiplicity is not common in the native Chinese scene, but then one wonders at the factors that limit or promote regional spread of many architectural features.

There are other minor criteria of interest in the regional patterns of architecture beyond those indicated in the section on minor architectural features. Occasionally in widely separated parts of China one finds villages with a completely covered central causeway or market arcade, having a storm drain down the middle. Or every house in a village may show some architectural peculiarity, such as special bracket forms or a single color of lacquer finish on all exposed wooden timbers. One may find a small town in which almost every house front has the same pattern of window and door arrangement. A town may be built in the style of another region of China. Some of these similarities and distinctions are easily explained, but not others. Szechwan shows many South China characteristics because in the eighteenth century permanent garrisons of southern soldiers were brought in. Paoshan, an important west Yunnan town on the Burma Road,

reminded many wartime refugees of the Nanking area because its architecture is inherited from a central Kiangsu transplantation by the fifteenth-century military garrison recruited from Nanking. What amounts to colonization has reprinted the architecture of many localities very widely over China. Sometimes a village or town is rebuilt after a disastrous fire, and some new local design catches the fancy and is repeated throughout the current construction program.

Although present-day China shows many building features not originally Chinese, distinctly Chinese patterns of architecture have penetrated deeply into parts of Southeast Asia. Sun-dried brick, the gray tile roof, the enclosing wall, and the rectangular house unit in transverse position have become variably blended into the architecture of French Indochina. Non-Chinese peoples have been pushing southward out of Southwest China and the Tibetan border country for centuries, but cultural relatives still inhabit those two areas today. To some extent the building patterns of these peoples are now distributed through West and Southwest China, French Indochina, Siam, and Burma. In each area introduced building habits have become interwoven with habits locally native to produce results somewhat different from those in the other areas. On the Burma border of Yunnan at least, house types have penetrated into the highlands from lowland Burma that are quite unsuited to the cooler highlands. And on Hainan Island there is a complex set of patterns ranging from modern Chinese back to early pre-Chinese forms, many of which were undoubtedly distributed centuries ago from South China down into the Netherlands Indies.[18] There is a suggestion of a preservation of a similar early type among the White Lolo slave peoples of northern Yunnan, but certainly on Hainan house forms have been preserved that are now extinct elsewhere in South China.

Although present knowledge of Chinese architecture will hardly support accurate generalization, it would seem that several suggestive conclusions can be drawn. An old North China "Chinese" house pattern, involving

[18] Stübel (H. Stübel: Die Li-Stämme der Insel Hainan, Berlin, 1937) records a wide variety of houses on Hainan. A type not recorded on the Chinese mainland has a circular roof reaching from the ground on one side to the ground on the other, without a gable and without end walls, constructed of bamboo and thatch, set on three lines of poles and plates running longitudinally through the house. The result is a single room 10 to 15 feet wide and 36 to 40 feet long. Another type is the split-bamboo house with raised bamboo floor. Several groups build a house with side walls only a foot or so high, having a simple gable roof resting on the outer walls and three lines of longitudinal posts. There are other variations, with different degrees of modification toward a Chinese-like architecture.

curtain walls, a straight sloping roof, transverse placement, an encircling wall, and a courtyard, gradually matured into two separate patterns and at the same time spread thinly over present-day China. A series of very early South China non-Chinese patterns based on bamboo and thatching materials and lacking the transverse placement, courtyard, and encircling wall were reduced in number through gradual cultural elimination, while at the same time the surviving patterns absorbed certain features from the invading North China patterns. Eventually such gradually evolving characteristics as the curved roof and ornamentation of walls and roofs spread out of the south over all of present China. Basic architectural principles of North China spread outward, particularly to the south, but at the same time Chinese colonists moving beyond the borders of the earlier culture hearth temporarily took up the architecture of their new surroundings. Either out of such an absorptive process or through importation by outsiders, such fundamental items as the flat mud roof and the Hellenistic pillar bases were blended into the developing Chinese modes. Certain other non-Chinese patterns of house building originally found in present-day West China have persisted as such only as long as their builders have remained in China and maintained their cultural identity. Some patterns have probably disappeared here too, where such groups as the Min Chia of Yunnan are now highly Sinicized. Where non-Chinese have withdrawn in the face of steadily advancing colonization, their house types have vanished, recognizably, after a short occupation by the Chinese, who use but do not rebuild the native houses as their hold on a frontier becomes tighter. In the long period of colonization of the periphery surrounding the original culture hearth and the elaboration of what is now modern Chinese culture the process of acculturation has had considerable influence on Chinese architecture.

There are now a variety of patterns to Chinese building, and most of them have some features in common. These types are to be found almost everywhere in China today, though they show considerable regional specialization of particular characteristics. There is a wealth of variation in building produced by differences in materials or in regionally developed principles of design and ornamentation. The impact of the Occident may well fundamentally modify Chinese urban architecture to a higher degree than has happened since the original crystallization of a "Chinese" architecture in North China. But, in their turn, Occidental plans and materials will yield to a process of Sinicizing that will alter them appreciably.

TVA ON THE DANUBE?*

GEORGE KISS

THE act creating the Tennessee Valley Authority was passed by the Congress of the United States in 1933. In brief, the main purposes of the Authority were stated as: maximum flood control; maximum development of the Tennessee River for navigation; maximum generation of electric power consistent with flood control and navigation; proper use of marginal lands; proper reforestation of lands in the drainage basin; and promotion of the economic and social well-being of the people in the river basin.

The objectives, methods, and results of TVA have been debated, discussed, criticized, and praised by students of all phases of its activities. One thing, however, can be said about it: it is, perhaps, of all peacetime agencies organized by the United States government the best-known beyond our frontiers. Whatever the merits or defects of the day-by-day activities of TVA, its achievements, both visible and invisible, on the face of the land and in the minds of the people of the Tennessee Valley, are sufficiently permanent to make a lasting impression on visitors to that valley. The main principle of the TVA act, integrated development of resources, has influenced regional development of natural resources, whether actually in execution or still in blueprint, in areas as far apart as British West Africa and the valley of the Yangtze.

Several writers, in their discussions of the underlying principles and the methods of TVA, have suggested that similar principles and methods be applied to other great natural regions of the world. David E. Lilienthal, Julian Huxley, Arthur Morgan, and others have pointed to the valley of the Danube River in Central Europe as an almost ideal regional unit for the organization of an authority similar to TVA. Although the Danube Valley is a major natural region, with boundaries, as Partsch pointed out some years ago, extending to, and in some places beyond, its watershed,

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* The author has studied various aspects of the Danube Basin and has taken many trips on the fluvial Danube, by steamer, barge, and skiff. This particular aspect is a review in the light of the accomplishments of TVA and the Columbia River Developments. Field studies made in the Columbia Valley were supported by a grant-in-aid from the faculty research funds of the Horace H. Rackham School of Graduate Studies of the University of Michigan. The author wishes to express his sincere gratitude for help and information received during his field studies in the Columbia Valley and the Tennessee Valley from the following: H. A. Morgan, H. K. Menhinick, W. L. Sturdevant, C. E. Blee, N. Bass, T. Augur, and J. P. Ferris of the Tennessee Valley Authority; Major S. E. Hutton, Bureau of Reclamation, Coulee Dam, Wash.; and P. J. Raver, N. C. Hazeltine, J. R. Criswell, and I. Bloch of the Bonneville Power Administration, U. S. Department of the Interior.

that geographical fact alone would hardly suffice to assure either the success or the defeat of such an agency. It is proposed here to discuss the possible objectives that such an authority might accomplish and to compare them with the objectives set by the enabling act of TVA. The results that might be expected from the accomplishment of the major objectives will then be scrutinized in the light of what little information is available at the present time on resources, physical environment, and so on. It must be pointed out, however, that although these potential objectives can be within the reach of an authority with sufficient vision, extensive powers, and adequate local and international support, they cannot be achieved, nor can the works here suggested be undertaken at all, until a radical change occurs in the political and economic climate of the Danube Valley.

A Regional Unit

"A river valley may be a logical regional unit and as such a means for realizing common purposes which require that state boundaries be transcended."[1] These words might well serve as the motto of any regional authority with the task of exploiting the resources of the Danube Valley. The Danube, greatest river of the European continent west of the Volga, rises in the Black Forest within 50 miles of the Rhine Valley and ends its tortuous course of more than 1800 miles in the Black Sea. Together with the Rhine, the Danube affords a routeway across Europe connecting the great industrial northwest, with its concentrations of population and industry, with the granaries of central Eastern Europe.

The course of the Danube is the result of its geological history. It crosses massifs and ranges, the Swabian Jura, the Bohemian massif, the western Carpathians, the volcanic ranges of central Hungary (Pilis and Börzsöny), and the Transylvanian Alps; it connects a series of rather well-defined basins, Bavarian, Viennese, Hungarian, and Rumanian. This alternation of narrows and wide lowlands has important effects on the regime of the river and on navigation. Suess compared the Danube to a rope stretched tight in some spots, where, therefore, its lateral movements are greatly restricted; in the slack sections, however, wide lateral movements of the river and its tributaries have created extensive flood plains and meanders.

The watershed of the Danube, with an area of some 315,000 square miles, compares rather favorably with those of other major rivers of Europe and the other continents. Although it is clearly defined everywhere except

[1] C. H. Grattan: A Hard Look at TVA, *Harper's Mag.*, Vol. 191, 1945, pp. 206–215; reference on p. 209.

FIG. 1—Map of the Danube Basin. The boundaries are as of February, 1947. For a large-scale map of the Danube see "Karte der Donau von Ulm bis zur Mündung," 1:125,000, Erste Donau-Dampfschiffahrts-Gesellschaft, Vienna. In addition to standard relief maps, "Environment and Conflict in Europe," *Amer. Geogr. Soc. Special Publ. No. 24*, 2nd edit., rev., 1940, might be consulted, and the reader should refer to the excellent maps (especially of structure and rainfall) in De Martonne's volumes on Central Europe in the Géographie Universelle series.

in the karst uplands of northwestern Yugoslavia, it is comparatively low: toward the Main, 1360 feet; toward the Mediterranean, at the Preshove saddle between the Morava and the Vardar, 1485 feet. These low divides have seldom constituted effective barriers between the Danube Valley and adjacent areas. Historically there was early frequent intercourse between culture areas of the Danube and those, for example, of the Aegean and the Baltic. Today there is the possibility of effective modern connection between the Danube and rivers to the north and northwest.

Need of Unified Control

The alternation of narrows and wide lowlands and the considerable difference between the upper and lower sections of the valley both in the amount of rainfall and in its seasonal distribution have made the Danube throughout most of its history an untamed and at times dangerous waterway. For more than a hundred years now the nations along its course have undertaken extensive and expensive works designed to regulate the flow, define and maintain the navigation channel, and prevent floods. Yet because of the disconnected nature of these works and the lack of coordination between the various governments the only effective series of improvements was that undertaken by the European Commission of the Danube, in the Danube delta. Even there, international strife during World War I and in the 1930's almost nullified decades of arduous and skillful work, with subsequent grave results for the navigation of the entire maritime Danube.

Along the fluvial Danube, the portion of the river extending upstream from Brăila, the results achieved by regulation in one section were often canceled by changes occurring in the section immediately below. For instance, at Vienna, in a section where extensive regulation was undertaken before 1895, the level at which the river inundated areas adjacent to its normal bed was considered to be at 4.3 meters. The highest flood crest observed at this station was 5.4 meters. At Bratislava, however, some 35 miles downstream from Vienna, the danger level of the river was at 5.5 meters, but the highest observed flood crest was at 9.82 meters.[2] Isolated and unconnected undertakings, expensive though they may have been, could not hope to achieve lasting results in the taming of the Danube. Beyond the benefits that navigation and flood control may derive from regulation of the river and its tributaries, there are those resulting from the generation of electrical energy.

[2] Amand v. Schweiger-Lerchenfeld: Die Donau als Völkerweg, Schiffahrtsstrasse und Reiseroute, Vienna, etc., 1896, p. 124.

In sum, the duties of an authority charged with the development of the resources of the Danubian region would comprehend improvement of the navigation channel and regulation of the tributaries through multiple-purpose dams and other works to further the technical advance of navigation, increase merchandise and passenger traffic on the river, render flood control more effective, and generate hydroelectric power; in some districts water from reservoirs might also be used for irrigation. Electric power derived from water and other sources would contribute materially to the advancement of agriculture and industry, thus raising the general standard of living in the region. The proposed objectives of such an authority would partake of the characteristics not only of its prototype, the TVA, but also of those of development projects on the Columbia River and on the Colorado River.

Divisions: The Upper Danube

For hydrographic purposes the Danube may be divided into three sections,[3] each about 600 miles in length. The upper Danube extends from Donaueschingen, considered the source of the river, to Devín, just above Bratislava, where the river enters the Hungarian Basin; the middle Danube extends from Devín to the downstream end of the Iron Gate;[4] and the lower Danube from the Iron Gate to the Black Sea. Up to the present time navigation for ships of 700 tons' displacement has been possible at all times on the lower section and most of the middle one but has been subject to seasonal interruptions on the upper section.

Both in the terms of the Danube Statute of 1921 and in the tradition of the river, the head of navigation lies at Ulm, in southern Germany. Actually, however, navigation for any except the smallest barges (less than 100 tons) has not been possible between Ulm and Kelheim, the terminus of the old Main-Danube Canal. At Regensburg, a short distance below Kelheim, the old Roman bridge prevented passage of even medium-sized craft. The destruction of part of this bridge in 1945 has not altered the situation materially, however, since the river channel is too shallow for all except light barges (average less than 150 tons). The section between Regensburg and Vienna is navigable for craft of 650 tons except during low water (usually less than 60 days) and when the river is frozen. In the narrows near Hofkirchen navigation locks and a powerhouse were installed between 1923 and 1926.

[3] Allix terms them Alpine, Pannonian, and Pontic respectively (André Allix: Le Danube jusqu'en 1939, *Les Études Rhodaniennes*, Vol. 17, 1942, pp. 93–130).

[4] "Iron Gates" is commonly used in English, but the singular form is generally preferred in the Danubian countries.

The locks make the river navigable for barges of 650 tons, and the dam, which has an installed capacity of some 42,000 kilowatts,[5] increases depth in the section above. Between Hofkirchen and Linz shoals and shore obstructions slow down navigation; widening of the channel and, possibly, installation of power dams may be feasible and desirable. The section between Linz and Devín should be considered in two subsections. Between Linz and Krems the river traverses a series of narrows, which increase the current and make navigation upstream difficult and expensive. This section of the river first underwent regulation in the "Strudel" rapids below Grein, between 1778 and 1795. Although the Strudel is now navigable for all except the largest passenger steamers, the speed of the current might be reduced here and navigation thus be made less expensive. Also, the potential hydroelectric energy makes the installation of power plants highly desirable. The section between Krems and Devín was extensively regulated by the Austrian government, and no considerable improvements seem necessary at the present time.

The Middle Danube

The 60 miles or so of the middle Danube between Devín and Gönyü present great difficulties to navigation. Below the city of Bratislava, about five miles from Devín, the Danube divides into three branches. The provisions of the treaties of Versailles and the Trianon and of the Danube Statute imposed on the riparian states the obligation to maintain the navigation channel in the middle branch, but the lack of adequate international cooperation and of a suitable program of works has made the Devín-Gönyü section a bottleneck. In the fall, when river traffic is unusually heavy because of the shipment of grain from the lower Danube to the middle and upper river, barge trains have to anchor at Gönyü and redistribute their load, in order to reduce the draft of the individual barges. The section below Gönyü, navigable everywhere except for a few days in the early fall and with a minimum depth of two meters, nevertheless presents some difficulties. According to the Hines report[6] there are 11 shoals in this section. Between Budapest and Novi Sad the channel could be shortened by at least 10 per cent; for in some sections—for example, between Dunaföldvár and Baja, between Baja and Bezdan, and especially in the angle formed by the Danube and the Drava—the river presents a bewildering maze of oxbow lakes,

[5] W. D. Hines: Report on Danube Navigation, *League of Nations Publs., C.444(a).M.164(a).1925. VIII*, Geneva, 1925, p. 121.

[6] *Ibid.*, p. 126.

cutoffs, and marshes. According to recent surveys the channel could be deepened here to an average of three meters, in the section below the mouth of the Tisza River possibly to as much as 4.5 meters. One of the curious features of the middle Danube in the section between the mouth of the Drava and the entrance of the narrow section at Baziaş is the effect of the southeasterly "Kosova" wind on the river flow. During the spring equinox this wind forces both the Danube and the Tisza, then at high flood level, against their right banks. The result is a constant shift of both rivers in a west-northwest direction. During the fall equinox, when the Kosova again blows at full strength, the rivers are low. The wind picks up sand from the vast exposed stretches and carries it west-northwest, reinforcing the stream shifts. The combination of the two factors results in a constant meandering of the rivers between Mohács on the Danube, Szeged on the Tisza, and Belgrade. A good example is the great meander of the Danube at Dalj, just below the entry of the Drava.

The Iron Gate Section

The picturesque 73-mile stretch from Moldova Veche to Turnu-Severin is referred to as the Iron Gate section, named after the last of the four narrows in this part. Here the Danube breaks through a chain of mountains extending in a general north-south direction from the upper Timişul River to the middle Morava. Strabo recognized the importance of the Iron Gate by assigning to it the role of dividing point between the upper and lower Danube, naming the former Danuvius and the latter Ister.

Between Belgrade and the entrance to the Iron Gate the average width of the river is 870 yards; in the Kazan narrows it is 164 yards. Through a series of works undertaken between 1830 and 1900, the Hungarian government blasted a navigation channel through the Kazan gorge and another through the Iron Gate, restricting the river to a channel 58 yards wide in the first passage, 82 yards in the second. The difference in elevation between Moldova Veche and Sip, at the entrance of the Iron Gate (see Fig. 1), is 82 feet. The combination of these two factors, an extremely narrow channel and a considerable difference in elevation, results in a great increase in the speed of the current. The rate of fall of the river between Gönyü and Belgrade, through most of the middle section, is 0.05 per mille; in the section of the narrows it is 0.16 per mille. The speed of the current increases from an average of 0.9 meter a second in the Gönyü-Belgrade section to 5 meters a second in the Iron Gate, which is equivalent to about 10 miles an hour. It was estimated that a 1000-horsepower tug took one hour to tow a 650-ton

barge through the Iron Gate channel, 1.05 miles long.[7] The powerful current of the Iron Gate channel made navigation through this section rather expensive, because dues had to be levied to defray the cost of towing. Before World War I, Rumanian corn and wheat were often shipped by railroad to Verciorova, at the upstream end of the Iron Gate, to avoid payment of the tolls.

Geological, hydrological, and engineering studies of improvements of the narrows section have been carried on for more than a hundred years, yet the work is far from complete. The present status of the section is unsatisfactory from both an engineering and an economic point of view. Navigation is costly, difficult, and sometimes dangerous. At the same time, the amount of electrical energy that could be generated in this section is potentially the greatest in the entire Danube basin. The great canyon, more than 70 miles in length, between the lower end of the Iron Gate and the entrance to the narrows might become a vast storage lake. The difference in elevation between the entrance to the narrows and their end combined with a channel depth that throughout the section is more than 100 feet and in the Kazan narrows reaches 174 feet would give a river dam installed below the Iron Gate sufficient head to operate a huge powerhouse. It has been suggested that at least one high dam be built at the downstream end of the Iron Gate, with a powerhouse and twin navigation locks. The capacity of this dam, which would depend on the storage capacity of the section above it, has been variously estimated at 350,000 to 1,000,000 kilowatts. Such a dam would also assure a minimum depth of three meters for the channel as far as Belgrade.[8]

The Lower Danube

The section of the fluvial Danube between Turnu-Severin and Brăila, although it presents minor obstacles such as shoals and a great number of secondary arms, sandbanks, and side channels, is navigable throughout. Here the river widens out occasionally to 1100 yards or more, and the flood plain in many places is more than five miles in width. Long marshy stretches occur, especially below Orehovo, mostly along the left bank. It is not until the Danube swings sharply to the north at Cernavoda, at the north end of the Dobruja platform, that the marshes follow the river along both banks.

[7] Franz Heiderich: Die Donau als Verkehrsstrasse, *Zeitschr. Gesell. für Erdkunde zu Berlin*, 1916, pp. 265–303.

[8] Hines, *op. cit.*, pp. 130–131; Otto Popper: The International Regime of the Danube, *Geogr. Journ.*, Vol. 102, 1943, pp. 240–253, reference on p. 250.

Navigation improvement here would mean primarily a widening of the channel.

The Maritime Danube

The last 106 miles of the river, between Brăila and Sulina, are referred to as the maritime Danube. Between 1856 and the outbreak of World War II the maritime Danube was administered by the European Danube Commission. The splendid record of this organization, which functioned throughout much of this period as a truly international body with nearly sovereign control over this important part of the river, illustrates the efficiency of international administration as long as it is supported by the wholehearted cooperation of all member states. Lack of such cooperation from World War I to World War II all but neutralized the earlier work of the European Danube Commission, and during the war the Commission itself was liquidated as a result of German control of the Danube. The resulting deterioration of the maritime Danube calls for extensive and immediate action. The heavy load of silt carried by the river in its lower course makes constant dredging indispensable. Prevailing currents of the Black Sea are a constant menace to the upkeep of the Sulina entrance of the river. The seriousness of these problems is illustrated by the fact that the Sulina lighthouse, built on the Black Sea shore in 1867, fifty years later was two-thirds of a mile from the sea.[9]

The International Commission of the Danube, instituted by the Versailles Treaty and the Danube Statute, devoted considerable time to the study of improvements of the river, and some of its recommendations would undoubtedly be realized under a Danube authority. Two basic suggestions made by the Commission should be accepted as a norm for the whole of the fluvial Danube. They are the maintenance of a minimum channel depth of two meters throughout the navigable part of the river (depths on the maritime Danube were considerably greater than two meters before 1939) and the regulation of the river to allow, through maintenance of a minimum width and a minimal radius of curvature, the simultaneous passing in both directions of barge trains with units of 1250 metric tons each.[10]

Dams on the Main Stream

The dam and navigation locks at Hofkirchen and the suggested similar installations at the Iron Gate would, undoubtedly, constitute two key con-

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[9] Oskar Kende: Die Donaustrasse, *Weltwirtschaftliches Archiv*, Vol. 10, 1917, pp. 215–303; reference on p. 244, note 18.

[10] Popper, *op. cit.*, p. 245.

trol points of the river. Other dams on the Danube are now being considered by the Austrian government, since it is on the upper section of the river that such structures would be most useful for navigation and generation of hydroelectric power. They include a series of three dams between Passau and Linz, a major dam at Ybbs-Persenbeug, now under construction,[11] a dam between Krems and Vienna, and, possibly, one other dam, between Vienna and the mouth of the Morava River, at Devín. All these structures would be of the multiple-purpose type, designed to improve navigation by maintaining a year-round depth of at least two meters in the channel, to generate power, and to control flood levels, especially in the Tulln depression between Krems and Korneuburg, and between Vienna and Devín.

Tributary Streams

The Danube depends for a good part of its water supply on tributary streams. Some of these streams are potentially navigable, though at the present time navigation is restricted to the Tisza. This river, the greatest of the Danube's tributaries, is navigable for nearly 300 miles at high water. During low water, when shipment of cereals would increase traffic, navigation is frequently limited to the lower course, between the confluence with the Maros and the junction with the Danube. Navigation improvements on the Tisza would require considerable work, shortening its course possibly by as much as 40 per cent, deepening the channel to at least 1.8 meters, and marking the channel to guide ships and barges. Among the tributaries of the Tisza, the Someşul, Körös, and Mureşul are theoretically navigable for various distances, but navigation at present is restricted to the floating of log trains and to small boats. Considerable regulation of these left-bank tributaries, and of the Hernád, the Sajó, and the Zagyva among the right-bank tributaries, would improve the stability of water level and at the same time lessen flood crests and provide, in several areas both east and west of the Tisza, water for irrigation. It is not suggested here, however, that dams be erected on these tributaries of the Tisza or on the Tisza itself, since neither the foreseeable traffic nor the demand for power would be likely to justify the capital outlay.

The Drava and the Sava, next to the Tisza, are the most important tributaries of the middle Danube. Both are theoretically navigable, but their channels seem to have deteriorated steadily since 1914. Before that date the Austrian Danube Steam Navigation Company maintained regular freight

[11] According to information received from the Representative of the Austrian Federal Government in Washington, D. C., December, 1946.

services on these rivers, but after 1920 no such services were scheduled, except for a few trips each season. Small local traffic might bear the burden of limited work to improve the channels to a point above Barcs on the Drava and to a point above Sisak on the Sava, and it was suggested, before World War II, that the Kupa River, a right-bank tributary of the Sava, be made navigable as far as Karlovac. It seems doubtful, however, whether traffic in this part of Yugoslavia could bear the cost of such an undertaking.

In the middle course of the Danube, two groups of other tributary streams claim attention. The Váh, the Nitra, the Hron, and the Ipoly descend to the Lesser Hungarian Plain from the heights of the Northern Carpathians; except for the last 10 miles of the Váh's course, they are not navigable. At the points where the streams leave the mountains, in the neighborhood of the cities of Nové Mesto on the Váh, Nitra on the Nitra, Levice on the Hron, and Shahy on the Ipoly, low dams would regulate the stream flow and contribute to a more regular water supply of the Danube; they would protect the rich agricultural areas of the Lesser Hungarian Plain from floods; and they would generate moderate amounts of power for local consumption.

Among the right-bank tributaries in this part of the middle course, the Rába, which reaches an arm of the Danube at Győr, is perhaps the most important. This river, with its tributaries, drains the southern section of the Lesser Hungarian Plain. Immediately above Győr it receives the waters of a small tributary, which drains the Neusiedler, or Fertő, Lake and the adjacent Hanság swamp. Even a moderate amount of dredging of the Rába would be of great local importance, since draining the Hanság swamp and part of the lowlands on Fertő Lake would greatly increase the available cropland. It would also raise water level in the Győr, or south branch of the Danube, and at Gönyü, a critical point of river navigation (see p. 279).

The tributaries of the upper Danube, both in Austria and in Germany, are for the most part true mountain streams—swift, shallow, with rapids occupying long stretches, capricious to the extreme in their regime. More often than not they are a menace to their valleys, bringing destruction and ruin during the spring floods, when their untamed, unregulated waters inundate the countryside. The Lech, the Isar, the Inn, the Traun, and the Enns are the most important tributaries of this section, all on the right bank; while the Morava and its tributary the Dyje (Thaya) are the only important ones on the left bank. The Lech, the Isar, the Inn, the Traun, and the Enns descend from the Austrian and Bavarian Alps; some of their tributaries are already harnessed for the production of hydroelectric power. It is generally admitted, however, that considerable work remains to be

done, and the Austrian government has detailed plans providing for regulation of the Traun and the Enns to control floods and to generate electricity. Similar undertakings on the Lech, the Isar, and the Inn would contribute materially to the regulation of water in the Danube and to flood control, and, through the installation of hydroelectric plants, they would become integrated with the already existing network of such plants throughout the Austrian and Bavarian Alps.

Canal Systems in Operation

The canal system of the Danube Valley is perhaps the poorest in Europe. At the present time it may be divided into two groups: canals on the upper river and canals on the middle river. On the upper Danube a canal was built in the early nineteenth century, starting at Kelheim, a short distance above Regensburg, utilizing the Altmühl River, passing through Nürnberg and Erlangen, and reaching the Main at Bamberg. The locks on this canal are so small that only barges with a capacity of not more than 127 tons can pass through it, and the average distance between locks is a little less than two miles. Except during World War I, and presumably during World War II, this Main-Danube Canal has had only local importance.

The second group of canals, built mostly during the latter part of the nineteenth century, connect the middle Danube and various tributary streams of that section of the river. Most of these canals are small; the depth of the water is seldom greater than 1.8 meters, and the water level has often proved to be too low for even the smallest barges and tugs. The Sió Canal in west-central Hungary connects Lake Balaton with the Danube just below Fadd-Tolna; the Sárviz Canal drains the Sárrét marsh, west of the town of Székesfehérvár, and connects with the Sió. Both these canals have an average depth of not more than one meter. The King Peter Canal connects Bezdan in Yugoslavia, below Mohács, with the town of Stari Bechij on the Tisza; the Prince Alexander Canal connects the King Peter with the Danube at Novi Sad. The Bega River is canalized between the city of Timişoara and the lower Tisza. All the canals of the middle Danube are of purely local importance; their traffic has been limited to shipments of grain at harvest time and occasional shipments of timber, coal, and building materials. Except for the Bega, King Peter, and Prince Alexander Canals, they are all in rather poor repair and do not represent any significant extension of the Danube river system.

Advocates of inland waterways have long maintained that a network of canals connecting the Danube with river and canal systems of adjacent

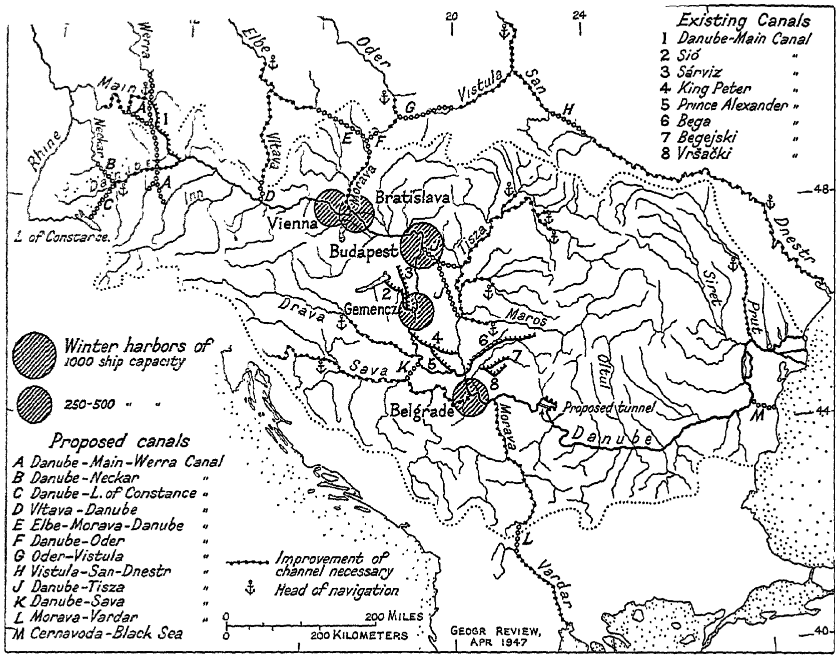

Fig. 2—Existing and proposed canals in the Danube system. The larger winter harbors also are shown (see Hines, *op. cit.*, p. 142).

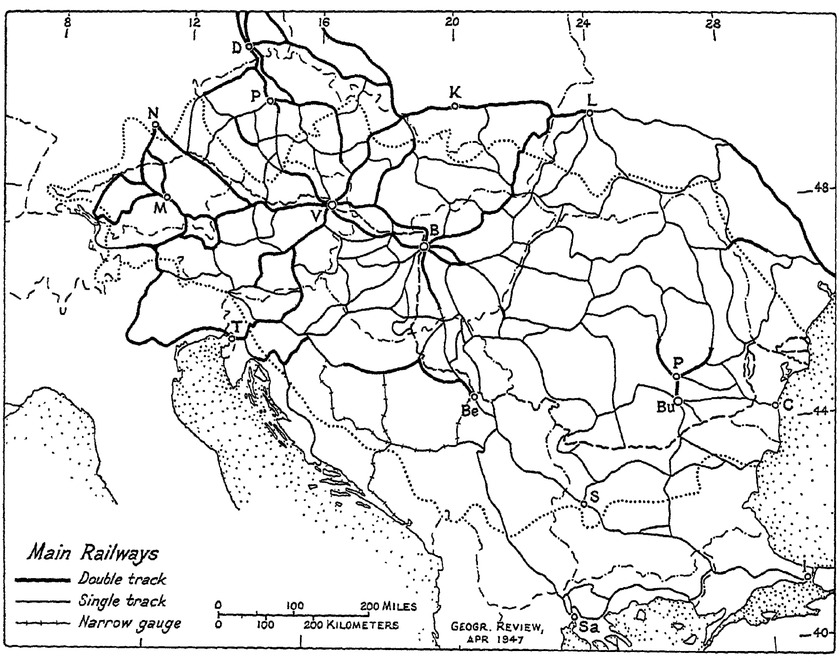

Fig. 3—Main railways of the Danube Basin. The basin is delineated by a dotted line.

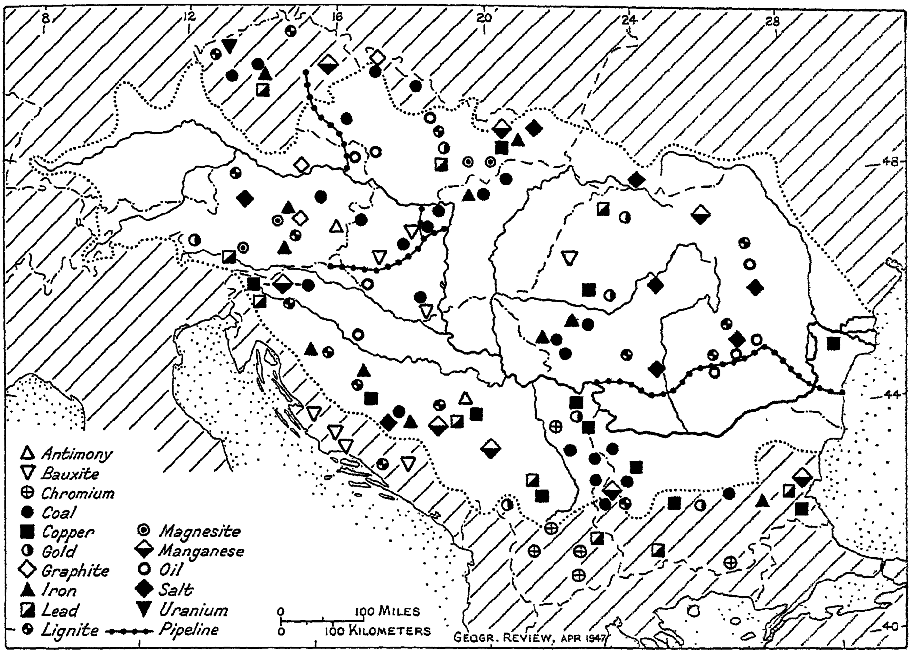

Fig. 4—Mineral resources of the Danube Basin.

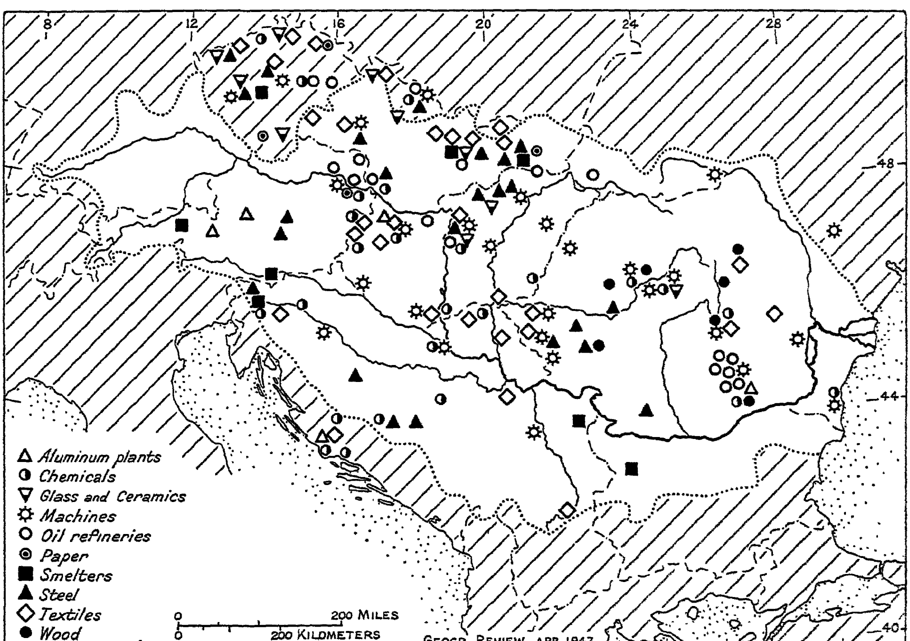

Fig. 5—Main industries of the Danube Basin, 1938.

regions would greatly increase the efficiency of the system. But it was not until World War I and the burden it placed on the railroads of Central Europe that the isolated voices of the supporters of inland navigation received any official recognition. The war was over, however, before the various plans, drawn up in the emergency or earlier, could pass from the blueprint stage to that of actual construction. The National Socialist regime of Hitler, intent on perfecting its transportation system, whether by superhighway, railroad, or water, was the first Central European government to place serious emphasis on canal construction and the improvement of navigable rivers. The canal leading from the Oder at Cosel to the Silesian industrial cities of Hindenburg and Beuthen was the tangible proof of this interest in any region close to the Danube system, and the great Mittelland Canal, connecting the Rhine, the Ems, the Weser, the Elbe, the Oder, and the Vistula, opened up the possibility of a through waterway system between the North, Baltic, and Black Seas.

Some Proposed Canals

Many of the canals suggested by engineers, geographers, and heads of government bureaus before and after World War I may well remain blueprints for long years to come. True, European waterways have always been the busiest inland waterways of the world, with the exception of the Great Lakes of North America. But canal construction and improvements on navigable rivers are often costly, and capital expenditure and probable returns are far from balancing each other.

Of the suggested canals connecting the Danube and Rhine basins, the main project concerns the construction of a new canal between the Danube and the Main.[12] It would leave the upper Main at Bamberg and reach the Danube at Neuburg, near Ingolstadt. An interesting feature is that the canal would cross the Danube at Neuburg by means of a bridge and would continue south to the cities of Augsburg and Munich. At the Neuburg intersection a series of locks would bring barges down to the river, since the canal level would be 25.3 meters above that of the Danube. The usefulness of this canal would lie principally in the creation of a waterway capable of carrying barges of at least 650 tons from the Rhine to the Danube. The original German plans called for a northward extension from Bamberg to the upper Werra and Weser Rivers. Such an extension would create a through waterway connection between the Danube and the Weser; its

[12] Egon Rágóczy: Das Projekt eines nord-südlichen Grossschiffahrtsweges . . ., *Petermanns Mitt.*, Vol. 62, 1916, pp. 321–326, 366–372, and 405–409.

usefulness, however, would be limited by the fact that it would duplicate the well-established waterway of the Rhine and the western sections of the Mittelland Canal.

A Rhine-Main-Danube canal could become one of the trunk waterways of Europe: it would provide, for the cereals and minerals of the middle and lower Danube, cheap transportation to the great industrial concentration of the middle and lower Rhine and thus enable the Danubian countries to compete more successfully for the markets of Northwestern Europe.

An Oder-Danube canal[13] would have for its objective the creation of an inexpensive transportation route to the Danube Valley for Silesian coal and metals. Between the World Wars, Poland and Czechoslovakia provided exceptionally low railroad rates for coal going from Polish Silesia to the Danube Valley, and the Czechoslovak government spent considerable sums on the construction of coal-loading facilities in the Danube ports of Bratislava and Komárno. As often happens, railroad competition may well militate against the adoption of the canal plans. Still, the existence of cheap transportation coupled with a limited amount of hydroelectric power generated by some of the dams on the canal, in a region where there is a sizable demand for power, should be taken into consideration.

Other suggestions are the construction of a canal from the Danube to the Sava, which would shorten the haul for upstream freight from central Yugoslavia by some 100 miles or more; the construction of a canal from the upper Serbian Morava to the Vardar, connecting Belgrade and Saloniki; and the project, suggested in 1915, to eliminate the Iron Gate by construction of a tunnel.[14] Such projects are likely to be confined to the drawing board, however; for the technical difficulties and the probable costs of construction would not be justified by the demand for transportation along the planned lines. There is one other canal project, however, seriously discussed by the Rumanian government, that should be mentioned; for it would bring about considerable changes in the lower fluvial Danube and eliminate the maritime Danube entirely.

After the establishment of the European Danube Commission in 1856, and pending the beginning of its operations on the maritime Danube, British shipping interests, dissatisfied with the 7-foot depth of the Sulina channel, suggested a Danube–Black Sea canal. This canal was to connect Cernavoda on the lower Danube with the Rumanian port of Constanța on

[13] Richard Hennig: Das mitteleuropäische Binnenschiffahrtsnetz und die Möglichkeit seiner Ausgestaltung nach dem Kriege, *Geogr. Zeitschr.*, Vol. 23, 1917, pp. 62–78; reference on p. 77.

[14] Kende, *op. cit.*, p. 243.

the Black Sea and thus would shorten the haul from Mediterranean and Black Sea points to Central Europe by about 150 miles. Great Britain obtained from the Turkish government a concession to build such a canal and a railroad parallel to it, and the railroad was completed in 1860. The canal was never built, but the plan reappeared many times in discussions concerning the maritime Danube, and there have been reports that construction was actually begun on it during World War II, though these reports have not been confirmed. Since the highest point on the projected course of such a canal would be 217 feet above sea level, locks would be necessary, and the supply of water for the canal would have to come from the fluvial Danube and the Black Sea, an undertaking involving costly construction and dubious efficiency. The project was considered important enough, in spite of these handicaps, to figure prominently in deliberations of both the European and the International Danube Commissions.[15]

Flood-Control Problems

Problems of flood control rank high among those confronting any future organization dealing with the Danube Valley. The constant danger of inundation, the recurrent material loss due to annual floods, the lack of adequate forecasting and of transmission of danger signals in backward areas—all these have made flood control a serious issue. Among destructive floods of the past was that of 1838, when the dikes above Budapest broke and for several days water stood 12–15 feet deep in the streets of Pest and thousands of houses were destroyed.[16] The flood of the Tisza in 1879 ruined the greater part of the city of Szeged. As recently as the winter of 1945–1946 the formation of an ice wall on the Danube within the city limits of Budapest threatened low-lying areas near the river with inundation, and the ice wall had to be dynamited.

The building of dikes and low dams on arms of the Danube and on some of the major tributaries lessens the danger of flooding only partly. Regulation in one section may have little or no effect on sections lying downstream; it should be undertaken throughout the entire river system. In the lower and middle Danube Valley dams and dikes were often built to protect large cities from floods on the assumption that a wide flood plain in the section immediately below the protected area would take up the

[15] Cf. Popper, *op. cit.*, p. 244; and Sir [H.] Osborne Mance: International River and Canal Transport, London, New York, Toronto, 1945, p. 68 (reviewed in this number of the *Geogr. Rev.*).

[16] Schweiger-Lerchenfeld, *op. cit.*, p. 518.

excess water. For example, although the danger level of the Danube (above which the river would flood the area beyond the dikes and embankments) was considered to be 5 meters in the city of Budapest and in the towns of Dunaföldvár, Mohács, and Novi Sad, the flood crest observed at these stations was 9.36 meters at Budapest, 7.43 meters at Dunaföldvár, 7.00 meters at Mohács, and 6.31 meters at Novi Sad. This shows how the flood plain of the river, unprotected for the most part between Budapest and Novi Sad, absorbed excess water and progressively reduced the flood crest in proportion to the distance traveled by the flood wave.[17]

Flood-control problems in the Danube Valley may, for the purposes of generalized discussion, be divided into four groups: hydraulic and hydrographic research; hydrometric and meteorological forecasting and information service; control of both the main river and its tributaries by dams, dikes, earthworks, and canals, and central control of water dispatching; and, finally, reforestation and afforestation in areas affecting flood levels.

Hydraulic and hydrographic research in the Danube Valley received a severe setback when, after World War I, international boundaries redivided the watershed and made exchange of pertinent information difficult and sometimes impossible. To remedy this situation, the Treaty of Trianon organized the Middle Danube Technical Hydraulic Commission, with the twofold task of safeguarding national interests where new boundaries interfered with the effective operation of flood-control measures and of regulating future operations in the field of flood control and similar fields. Although the Commission achieved some impressive results, especially in exchanging and transmitting flood information promptly when the regular diplomatic channels might have proved too slow, it did not succeed in establishing complete cooperation between its member states—Austria, Hungary, Czechoslovakia, Yugoslavia, and Rumania.[18]

Hydraulic and hydrographic research, of the type conducted in the United States by the Corps of Engineers of the United States Army, the Bureau of Reclamation, and the Tennessee Valley Authority, will be one of the great tasks of a future Danube Valley Authority. The chief engineer of TVA expressed this in a recent address: "In no other phase of reservoir operations is the application of hydraulic principles so important as in operation for flood control. Coefficients of discharge for the various types of spillways, for sluiceways and for turbines must be known; the time of

[17] *Ibid.*, p. 124.
[18] Mance, *op. cit.*, pp. 69–70.

travel of translatory waves of water through open channels and through reservoirs must be accurately estimated."[19]

Hydrometric and meteorological service in the Danube Valley is far from adequate. Stations on the main river furnish data on water levels, flood crests, and the like, but little information is available regarding the tributaries. A central agency to collect such data, interpret them, and transmit pertinent information in the quickest possible way, perhaps by teletype, to regional flood-control and navigation offices should be an integral part of a regional authority. Similarly, weather stations already in operation should be supplemented along the tributaries. Automatic rain and stream gauges, gauges transmitting information by radio signals, should be used during periods of flood danger in remoter areas; for example, in the northeastern Carpathians, in the Transylvanian uplands, and in the southern uplands of Yugoslavia. Such gauges are in use in parts of the Tennessee Valley, and their contribution to hydrometric forecasting is very valuable.

Control of the Danube, and of certain important tributaries already discussed, will involve long and detailed studies, both in the field and in engineering laboratories. The construction of new dams must be preceded by field studies of the geological and hydrological nature of the environment, of soil structure and vegetation cover, both in the reservoir and on slopes draining toward it, of the best locations for penstocks, spillways, locks, and power stations; and these inquiries must be supplemented by laboratory studies of scale models of the dams. Furthermore, efficient flood control presupposes the existence of an elaborate and centrally directed system of water dispatching. Water dispatching controls floods, ensures the depth of navigation channels, and regulates the power output in multiple-purpose dams. Efficient water dispatching can reduce flood levels within a short time when the main river and tributaries have been brought under control. In his previously quoted address, the chief engineer of TVA estimated that, had all TVA's reservoirs been in operation at the time, "the 1937 flood crest of the Mississippi would have been reduced approximately 2 feet at Cairo and . . . reductions of 2 to 3½ feet would have been made in other important floods."[20]

Reforestation and afforestation are intimately connected with flood control, since the vegetation cover of a watershed influences runoff and thus affects flood crests and discharge of the river system. Early recognition of

[19] C. E. Blee: Hydraulic Operations of the System of the Tennessee Valley Authority: Address before the Hydraulics Division, American Society of Civil Engineers, New York, Jan. 20, 1944, p. 3.

[20] *Ibid.*, p. 15.

these principles found expression in the attempts made by several of the Danubian countries, especially Austria-Hungary, to protect remaining stands of commercial timber, to plant trees on cutover land, and to induce forest growth in areas lacking adequate cover. These attempts, made mostly before 1914, were seriously hampered by reckless cutting in critical areas of the watershed after World War I, and the results of excessive lumbering were reflected in the serious floods of the 1920's and 1930's, which occurred especially on the northern and eastern tributaries of the Tisza.

Irrigation

Questions concerning irrigation should also be within the competency of a regional authority. Although most of the Danube Valley receives at least 20 inches of annual rainfall, the seasonal distribution and periodicity make irrigation desirable in parts of the middle and lower valley. The lowlands of eastern Hungary, of northern Yugoslavia, and of southern and southeastern Rumania would be the areas where irrigation could increase crop yields and productivity. At the present time, to the knowledge of the writer, only one such scheme is under contemplation. Waters of the Danube, the Tisza, and the Kőrös are to be diverted to irrigate some 750,000 acres in four areas: near Dömsöd, south of Budapest; in the Hortobágy, a semi-steppe west of Debrecen; along the lower Kőrös near Szarvas; and east of the Tisza, near Szeged. The principal results expected from this irrigation scheme are an increase in the yield of feed crops, a corresponding increase in livestock, and a surplus of beef, pork, and dairy products, to be shipped to neighboring urban areas and to foreign markets.[21]

Hydroelectric Power

The costs of developing and maintaining a system of flood control, constructing and operating a major waterway 1800 miles long, and undertaking the surveys necessary to achieve these objectives would be enormous. No matter how efficient navigation might become, how many acres of farmland be spared the annual destruction caused by uncontrolled waters, these improvements alone would hardly justify the staggering capital investment required by a program of such proportions. Recognition of a similar fact prompted the originators of TVA and other regional development schemes in the United States to support the idea of multiple-purpose dams. Such dams, besides controlling floods and ensuring an adequate depth in the navigation channels at all times, generate hydroelectric power and thus

[21] Ujlaki-Nagy: Öntözőgazdálkodás (Irrigation Economy), *Közgazdaság*, Budapest, Sept. 8, 1946.

contribute to the amortization of the initial costs of construction, eventually turning their income into net gain. Two points should be emphasized in connection with multiple-purpose dams: the conditions under which they can operate, and the relation of power generated by hydraulic energy to power generated by other sources.

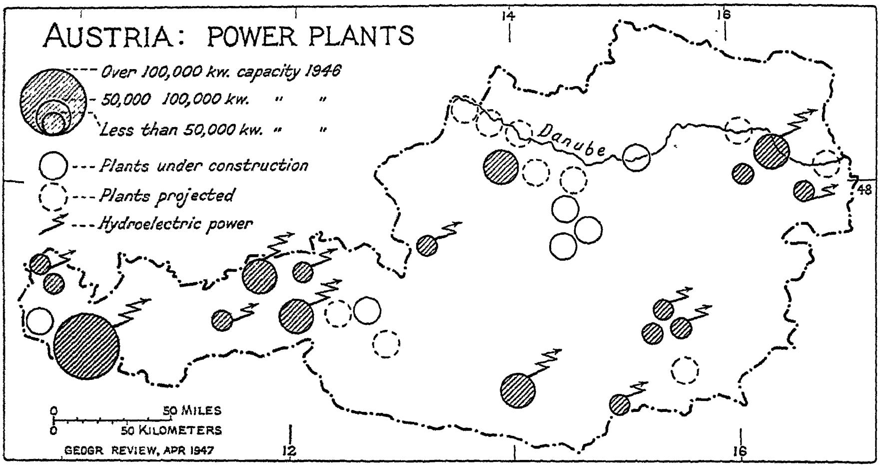

FIG. 6—Power plants in Austria, 1946 (see p. 299).

The experience gained in the operation of multiple-purpose dams on the Tennessee and the Columbia emphasizes three conditions necessary for successful functioning. First, major floods of the river thus controlled should occur at a definite season. This seems to be true of the Danube system, where floods are confined mostly to the early spring. Second, large storage capacity should be available at moderate cost. In the Danube Valley this condition would be relatively easy to meet, by limiting dams on the main river to a very few and utilizing the tributaries, especially in their upper courses, to the utmost. Third, the annual runoff cycle should permit refilling of the reservoirs after the flood season. The water level of the Danube and of most of its tributaries decreases gradually between April and September; thus the third condition seems to be present. These conditions determine the amount of power available at any time within a power grid, and also the amount of power available for exchange with other systems or to be borrowed for emergency use.

The second point concerns the relation of hydraulically generated electric energy to that generated by coal, natural gas, or petroleum. This relationship should determine the location of hydroelectric plants and the supplementing of hydroelectric power by, and cooperation of hydroelectric power with, these other sources of power.

Location and Integration of Power Blocks

The location and integration of "power blocks," rather than the location of individual plants, should be the principal initial concern, since the most suitable sites for the latter cannot well be determined until detailed surveys of locational factors have been made. In a discussion of "power blocks"

Table I—Installed (1935) and Potential (Estimated) Hydraulic Power in the Danubian Countries*

(In thousands of horsepower)

Country	Installed	Potential min. flow	Potential med. flow	Percentage Installed to Potential min. flow	Percentage Installed to Potential med. flow
Czechoslovakia	155	1,000	1,300	15.5	12.0
Austria	900	1,660	6,000	5.4	1.5
Hungary	25	200	300	12.5	8.4
Rumania	110	1,600	6,000	6.9	1.8
Yugoslavia	250	3,000	7,500	8 3	3.3
Bulgaria	25	1,000	2,200	2.5	1.1

* Source: "Economic Development in S.E. Europe," P E P (Political and Economic Planning), London, 1945, p. 49.

and their interconnections, the fact that power cannot be transmitted economically beyond a certain distance, ranging from 250 to 350 miles, should be given serious consideration. The loss of power beyond the economic limits of transmission might nullify much of the gain obtained by the operation of multiple-purpose dams.

Within the Danube Valley all the chief sources of energy at present used exist in varying quantities. Czechoslovakia is the only important producer of coal, and most of the lignite and brown coal mined there is used for the generation of electricity. The other Danubian countries possess only small reserves, of local importance. Rumania is a major producer of petroleum, and Austria and Hungary have developed minor oil fields since the late 1920's. Much of the Rumanian, Hungarian, and Austrian petroleum is exported, and the remainder is used mainly for transportation and as a source of light in rural areas. Natural-gas wells occur at Neusiedl a/d Zaya, near Vienna, and at Sarmazel, east of Cluj, in Transylvania. Any scheme for the integrated development of the resources of the Danube Valley must consider the distribution of these sources of power.

In the light of the foregoing general considerations it is suggested that the power system of the Danube Valley be centered on six areas. Each of these would generate and distribute power, but the sources of power would vary, including hydroelectric power alone and in combination with power

generated by natural gas or coal, and power generated by natural gas and petroleum alone.

The first area would comprise the western provinces of Austria—Vorarlberg, Tirol, and Salzburg—and southern Bavaria. At present this area leads in the production of hydroelectric power in the Danube Valley, and further extensions of the capacity now available would place it in a position to provide power for much of western and central Austria and for southern Germany. Power would be generated here exclusively by water, in powerhouses built in connection with high dams on the tributaries of the Danube. This power would be used for transportation, since a large part of the Austrian, and part of the German, railroads in the area are electrified; for industrial purposes; and for domestic and agricultural purposes, especially in the important dairy industry.

The second area would comprise eastern Austria and southeastern Bavaria. Here electricity would be generated mostly by water, and, in some existing power plants, by steam and natural gas. Dams on the Danube between Passau and Devín and on the Main-Danube Canal would supplement the electricity produced by dams on the right-bank tributaries of the Danube in Bavaria and Austria. Markets for the power produced here would include the Danube Valley group of industries in Austria between Linz and Vienna, the metallurgical industries of Styria and Carinthia, and possible new industrial plants in Bavaria, eastern Austria, and western Hungary.

The third area would consist of the larger part of Bohemia, the area drained by the Elbe and Vltava (Moldau) Rivers. Power generated here comes almost exclusively from steam plants, and most of it finds ready markets in the great industrial region centered on Prague and Plzeň.

The fourth area might be described as the Moravian-Slovakian area. It would comprise all of Moravia and Slovakia and, possibly, Czech Silesia. Power in this area would come from three sources: low dams on the Oder-Danube Canal and possibly on the Elbe-Danube Canal; high dams on the left-bank tributaries of the Danube in Slovakia; and coal mined in Moravia and Silesia. The existing industries of Moravia, Slovakia, and Silesia would absorb part of the power generated here; additional markets would have to include new industries in Slovakia and northern Hungary.

The fifth "power block," probably the greatest single unit to be put into operation, would be the Iron Gate power plant. Estimates differ, but most investigators of this site, ideal for the development of a major hydroelectric center, agree that the Iron Gate dam (possibly two dams, one above

the rapids and one below) should have a rated capacity of at least 400,000 kilowatts. Some authorities go as far as a million kilowatts, a figure that would compare rather favorably with the total rated capacity of Grand Coulee and Bonneville Dams.[22] Power produced here might be distributed through northern, central, and southern Yugoslavia, with its important

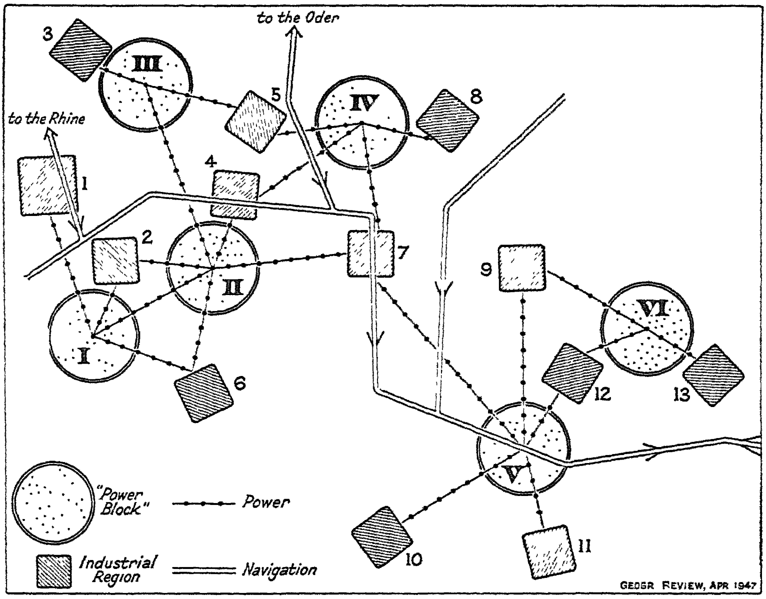

FIG. 7—Diagram of traffic and power for a Danube Valley Authority. "Power blocks": I, Western Austria–Southern Bavaria; II, Eastern Austria; III, Bohemia; IV, Moravia–Slovakia; V, Iron Gate; VI, Transylvania–Valachia–Moldavia.

Industrial regions: 1, North Bavaria–Franconia; 2, South Bavaria–Central Austria; 3, Bohemia; 4, Austrian Danube–Styria; 5, Moravia–Western Slovakia; 6, Carinthia–Slovenia–Western Croatia; 7, Hungary (West and Central); 8, Eastern Slovakia–Ruthenia; 9, Eastern Hungary; 10, Eastern Croatia–Bosnia–Serbia; 11, Western and Central Bulgaria; 12, Western Rumania and Transylvania; 13, Eastern Rumania.

Note: None of the lines of power flow indicated on the diagram exceeds 250 miles in length.

deposits of light metals and its rich farmlands, through central and southwestern Hungary, where deposits of bauxite and agricultural industries could easily absorb more power, through the basin of Transylvania and the oil fields of Rumania, and through the mining areas of northern and western Bulgaria, creating new centers of electrochemistry, of electrometallurgy, and of agricultural industries.

The sixth area, inferior to the other five in importance and capacity,

[22] In 1944 this was 1,316,400 kilowatts. See the report of the Bonneville Power Administration, *U. S. Dept. of the Interior Ann. Rept. for 1944*, pp. 41–62; reference on p. 41.

would be the mountainous triangle of Transylvania and the adjacent southern and southeastern slopes in Valachia and Moldavia and in Ruthenia. Here natural-gas and petroleum wells and locally important lignite deposits could

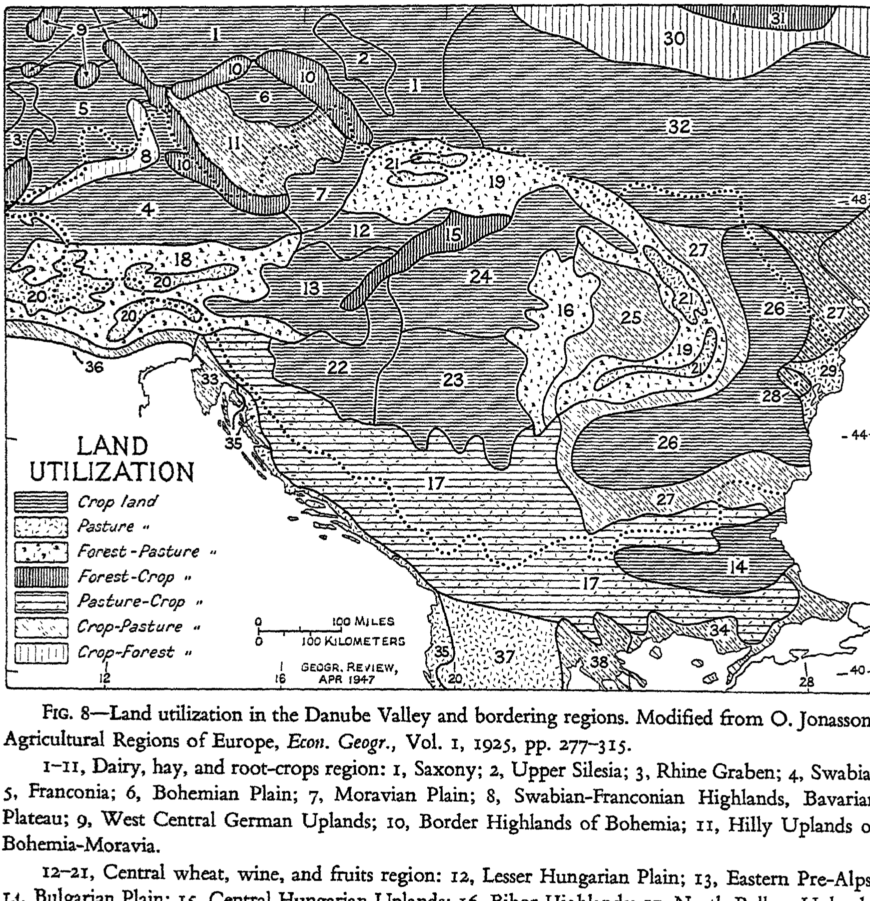

FIG. 8—Land utilization in the Danube Valley and bordering regions. Modified from O. Jonasson: Agricultural Regions of Europe, *Econ. Geogr.*, Vol. 1, 1925, pp. 277–315.

1–11, Dairy, hay, and root-crops region: 1, Saxony; 2, Upper Silesia; 3, Rhine Graben; 4, Swabia; 5, Franconia; 6, Bohemian Plain; 7, Moravian Plain; 8, Swabian-Franconian Highlands, Bavarian Plateau; 9, West Central German Uplands; 10, Border Highlands of Bohemia; 11, Hilly Uplands of Bohemia-Moravia.

12–21, Central wheat, wine, and fruits region: 12, Lesser Hungarian Plain; 13, Eastern Pre-Alps; 14, Bulgarian Plain; 15, Central Hungarian Uplands; 16, Bihor Highlands; 17, North Balkan Uplands; 18, Alps—forest and pasture; 19, Carpathians—forest and pasture; 20, Alps—pasture; 21, Carpathians—pasture.

22–29, Corn and wheat region: 22, Trans-Danubian corn and wheat area; 23, Central corn area; 24, North central wheat and tobacco area; 25, Transylvanian corn and wheat area; 26, Central wheat area; 27, Surrounding wheat and corn area; 28, Northern Dobruja hills; 29, Danube delta pastures.

30–31, Rye and buckwheat region.

32, Sugar-beet and winter-grain region: Kiev intensive sugar-beet area.

33–37, Humid and subhumid wheat and mediterranean fruit region: 33, Istria; 34, Southeastern Balkan coastal area; 35, Dalmatian coast; 36, Alps-Lombardy transition zone, citrus fruits and wine; 37, Southern Balkan uplands; 38, Macedonia.

help create a small "power block" designed to meet the immediate demands of the lower Danube Valley and acting as an extension of the great center of the Iron Gate.

Lack of adequate data makes estimates of the amount of power that could be obtained from such an integrated network of plants in the Danube Valley liable to serious criticism. Few figures are available for comparison with production data of other major power systems. The following estimates of the output of electric power in Austria were furnished to the writer by the Washington Representative of the Austrian Federal Government: In 1946 Austria produced 4 billion kilowatt-hours (Fig. 6). When projects now under construction are completed, another 4 billion kilowatt-hours will be added to the annual output, making a total annual output of 8 billion kilowatt-hours by 1952–1953. In comparison, the Bonneville Power Administration distributed 6.5 billion kilowatt-hours in the fiscal year 1944; TVA produced 9.1 billion kilowatt-hours in 1943.[23] Thus one might hazard the prediction that a system controlled and unified by a Danube Valley Authority might, in view of present figures, produce several times as much power as major regional systems now in operation in various parts of the United States.

The greatest problems are raised by the choice of dam sites and by the marketing of the energy produced. In the first case, even if all the Danubian countries should be willing to accept the advice and counsel provided by a regional authority, considerations favoring one site over another, or one region over another, might lead to well-nigh endless discussion.

As regards the problem of marketing the energy produced by hydroelectric, steam, and gas plants throughout the Danube Valley, the answer would have to take into consideration not merely present conditions but possible and probable trends of the future. Most students of the Danube Valley agree that the differences in living standards and in the degree of industrial development and of rural overpopulation that separate the Danubian countries make predictions rather difficult. There cannot be any doubt as to the magnitude of the change that would have to come over the Danube Valley to make such developments possible.

"Electricity is the most humane and the most efficient form of energy. It is mobility itself: It can be brought to people; people need not be brought to the source of energy. Electricity symbolizes the multiplication of human energies through science. But benefit, lasting and secure, will result only if the potentialities of power are seen as a whole, utilized not as ends in themselves but to aid in sustaining and restoring resources."[24] Such an integrated

[23] [Report of the] Bonneville Power Administration, *loc. cit.; Ann. Rept. Tennessee Valley Authority for 1943*, p. 35.

[24] D. E. Lilienthal: TVA: Democracy on the March, New York and London, 1944, pp. 55–56.

view of all the resources of a given region, as expressed by one of the leading exponents of that philosophy, might provide our answer. There are many ways in which additional power might find a market and people ready to use its services. Rural overpopulation in most of the lands of the middle and lower Danube Valley creates a sizable reservoir of manpower.[25] Although the lack of coal and iron ore precludes any immediate prospects of enlarging the existing plant of heavy industries in the Danube Valley, the occurrence of a variety of light metals, of natural gas, and of petroleum would seem to point toward the development of electrochemistry and electrometallurgy. Agricultural industries could use present and new crops and develop canning and food-freezing plants whose products would be readily marketable in Northwestern and west Central Europe. As in the valley of the Tennessee, research and pilot plant development should be one of the principal tasks of a new agency.

Danube Navigation before World War II

Generation of power, flood control, and development of river navigation were the three main objectives set out at the beginning of this study for a regional authority on the Danube. In view of the importance attached to improvement of the navigation channels and the construction of new canals, it might be well to review very briefly the state of Danube navigation before World War II.

Perhaps the outstanding feature of the traffic on the Danube was its small volume. It was less than four million tons in 1923 and 1924[26] and during the depression was greatly diminished. In 1936, a peak year in the inter-war period, it was about 7½ million tons (exclusive of the traffic on the maritime section),[27] about 10 per cent of the traffic on the Rhine. Among the reasons given for the backwardness of Danube navigation, the economic condition of the lower and middle Danube regions is perhaps the most important. Other reasons are the lack of downstream freight, the inadequacy of port and harbor installations, technical difficulties encountered along the waterway, the fact that the Danube empties into a closed sea, the restrictive trade

[25] See, for example, the maps in W. E. Moore: Economic Demography of Eastern and Southern Europe, *League of Nations Publs., II. Economic and Financial, 1945.II.A.9,* Geneva, 1945, pp. 67 and 73.

[26] Cf. Hines, *op. cit.*, p. 70; Gustav Pollaczek: Rebuilding the European Transportation System, *Studies in Postwar Reconstruction No. 5,* American Labor Conference on International Affairs, New York, 1945, Table 6. Pollaczek remarks that the Hines report is "probably the last reliable survey of the Danube traffic."

[27] "Economic Development in S. E. Europe," P E P (Political and Economic Planning), London, 1945, pp. 50–51.

practices of the Danubian countries, and, not least, competition from railroads and ocean carriers.

In 1913 a river barge could proceed from Passau to Orsova without frontier formalities. In 1937 frontier stops had to be made at Passau, Linz, Bratislava, Szob, Mohács, Bezdan, Gradişte, and Turnu-Severin. This was 18 years after the Danube had been made an international waterway! The loss due to frontier formalities in 1925 was estimated to be 5000 barge days,[28] to which financial losses in the form of tug fees, taxes, customs fees, and the like had to be added.

Competition from railroads and ocean carriers increased shipping difficulties on the Danube. In 1929 a ton of wheat shipped from Budapest to Regensburg by the river and thence to Mannheim by railroad paid 38 marks in freight charges; a ton of American wheat shipped to Mannheim paid 19 marks in freight charges. A ton of Hungarian wheat shipped from Budapest to any of the Rhine or Elbe ports via Brăila and the Mediterranean had to pay 30 marks in freight charges; a ton of United States wheat in those ports carried only 11 marks in freight charges.[29]

Finally, the technical handicaps were by no means inconsiderable. A tug of 600–700 horsepower could tow 8 fully loaded barges with a total pay load of 5200 tons, at 5 kilometers an hour, from Sulina to the Iron Gate, or from Belgrade to Gönyü. Between Gönyü and Passau, however, the same tug could tow only 3 fully loaded barges, with a total pay load of 1950 tons. Thus, if we take towing costs in the lower and middle sections as equal to 1, towing costs on the Danube above Gönyü would have been 2½ times that amount, in the Iron Gate section 3½ times.[30]

Navigational improvements would undoubtedly remove some of the handicaps, but only a radical change of economic and political conditions in the Danube Valley would make this great river a true avenue of trade.

This discussion of the problem of an authority for regional, integrated development of resources in the Danube Valley is primarily a geographical one; that is, a survey of available resources and their possible utilization, with emphasis on distribution patterns. The organizational problem—constitution, powers, administrative structure of such an authority—is primarily political. However, in view of its bearings on the technical problem

[28] Hines, *op. cit.*, pp. 33 ff.

[29] A. Tibal: Les communications dans l'Europe danubienne, *Conciliation Internationale*, Nos. 8–9, 1933, pp. 894–902.

[30] Kende, *op. cit.*, p. 224, note 14.

it is of some interest to append here a paragraph taken from a bill proposing the establishment of a Columbia Valley Authority.[31] Senator Mitchell of Washington, author of the bill, proposes that "to insure the integrated and coordinated promotion of navigation, control, and prevention of floods, safeguarding of navigable waters, reclamation of lands and protection of property of the United States, no dam, appurtenant works, sewer, dock, pier, wharf, bridge, trestle, landing pipe, building, float, or other or different obstruction or polluter affecting navigation, the use of navigable waters, flood control and prevention, lands, or property of the United States, shall be constructed, or operated or maintained, over, across, along, in, or into any stream or watercourse in the Columbia Valley region, except in accordance with such regulations relating to such construction, operation, and maintenance as may be prescribed by the Corporation." Any authority desirous of accomplishing its ends must have powers similar to these in order to ensure proper functioning of the complex and extensive mechanism in its charge.

An authority charged with the planning, construction, and maintenance of a system covering 315,000 square miles and involving, directly or indirectly, some 80 million people would have to have strong political backing to fulfill the hopes and aspirations that went into its making. It would also have to command capital resources beside which the 350 million dollars spent on power development in the Tennessee Valley between 1933 and 1943 would seem insignificant. Furthermore, such an authority would have to have at its call a vast trained army of technicians and executives, engineers and foremen, geologists and agronomists.

The Danube Valley has found itself in the path of war twice within the lifetime of one generation. Destruction and despair have brought the efficiency of the people to its lowest ebb. Financial ruin has depleted the resources at the disposal of their governments. Without large-scale financial and technical support a "TVA on the Danube" must remain an empty dream.

The challenge presented is worthy of great effort. The original TVA rose out of the depths of the world economic depression of the 1930's. Can such a process repeat itself? Could the work of a Danube Valley Authority, work of decades, involving vast sums of money and millions upon millions of man-hours, bring a modicum of peace and prosperity to one of the stormiest corners of our planet? This is the challenge of the Danube.

[31] S. 460, February 5, 1945, "A Bill to Establish a Columbia Valley Authority . . .," Sect. 202, pp. 52-53.

CAPTAIN BELLINGSHAUSEN'S VOYAGE 1819–1821*

ROBERT CUSHMAN MURPHY

Then felt I like some watcher of the skies
When a new planet swims into his ken.

THE exulting sentiments of Keats may be not inappropriately applied to the first complete translation of the journal of a Russian circumnavigation, in high southern latitudes, that ended 126 years ago. Some of Bellingshausen's narrative had already been rendered piecemeal into English and other European languages, and the essentials of the geographical discoveries and of the track along segments of the Antarctic ice were long ago made known through international hydrographic channels. The only detailed, and more or less supplementary, abstracts that preceded the Hakluyt edition of the whole journal were those of Lowe (1842)[1] and Gravelius (1902).[2]

Professor Debenham, in the Preface to the two volumes, recounts the history of the English version, which has been on the desks of a succession of Russian-language scholars since the First World War. The editor himself finally "set about harmonizing the work of the various translators, in order to produce a text which would be uniform in style." In the achievement of this difficult aim he seems to have attained a high degree of success, though the account still exhibits certain consecutive or alternating mannerisms of vocabulary and phraseology. The footnotes elucidating references to natural history are likewise of surprisingly unequal merit, sometimes reflecting expert opinion and sometimes recording errors of fact and misspellings of technical names.

The present reviewer, having no knowledge of Russian, enlisted the aid of Mrs. Tatiana Meyrer, of the library of the American Museum of Natural History, who translated aloud various critical passages from the original. The only instances in which the Hakluyt rendering was not fully confirmed related to a few natural phenomena and to choice of words. *Techenie*, according to Mrs. Meyrer, should be translated "current" rather than "stream," as it appears throughout the English text.

In an Introduction of 20 pages, the editor supplies an illuminating commentary on Thaddeus (hitherto usually Englished as "Fabian") Bellingshausen and his period. The commander's training, fitness, familiarity with the explorations of his predecessors, and fervent admiration of James Cook are clearly set forth. The then new Russian interest in the Pacific is explained by the settlement of easternmost Siberia. Bellingshausen had served, indeed, under Kruzenstern on the first Russian voyage round the world.

Professor Debenham also presents an able summary of the place of Bellingshausen's work in Antarctic annals and ascribes its relative obscurity partly to its efficiency and masterfulness. He reminds us that an expedition whose history claims a large reading public is usually one that has had either spectacular good fortune or great disaster.

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* The Voyage of Captain Bellingshausen to the Antarctic Seas, 1819–1821. Translated from the Russian. Edited by Frank Debenham. Vol. 1, xxx and 259 pp.; Vol. 2, viii and 261–474 pp.; maps, ills., index. *Hakluyt Soc.* [*Publs.*], Ser. 2, Vols. 91 and 92, London, 1945.

[1] F. Lowe: Bellingshausens Reise nach der Südsee und Entdeckungen im Südlichen Eismeer, [*A. Erman's*] *Archiv für Wissenschaftliche Kunde von Russland*, Vol. 2, Berlin, 1842, pp. 125–175.

[2] F. von Bellingshausens Forschungsfahrten im Südlichen Eismeer, 1819–1821: Auf Grund des russischen Originalwerks herausgegeben vom Verein für Erdkunde zu Dresden [translated by H. Gravelius], Leipzig, 1902.

From the very fact that Bellingshausen's more notable accomplishments, which included the supplementing of Cook's course, the four crossings of the Antarctic Circle, and the barely missed discovery of the continent, are already familiar to geographers, the journal in English is chiefly interesting and significant for its items of secondary importance—the side lights appear brighter than the main beacon. The manner of telling may be said to outrank the theme itself; and personal, subjective, even trifling, information is of greater value because of the century and a quarter during which it lay in darkness.

Two Russian expeditions, each to be made up of two naval craft, were planned under the patronage of Alexander I. Simultaneously with Bellingshausen's Antarctic voyage, two ships under command of Vasilev were to proceed to Bering Strait, seek the Northwest Passage along the Arctic coast of America, and return to Russia, if possible, via the Atlantic. The names of the vessels had a quaint and disarming quality that contrasts with the powder-and-shot connotation of those of many contemporary British men-of-war. Bellingshausen's craft were the *Vostok* (East) and the *Mirnyi* (Peaceful), those of Vasilev the *Otkryitie* (Discovery) and the *Blagonamyerenny* (Well-Intentioned)!

Bellingshausen's sloops of war were rigged and equipped with a care that is impressive even to a modern reader. Their character and fittings were also admired by British naval men encountered during the voyage. The navigational instruments were the best that the time afforded, and it is evident that the Russian officers were extremely competent, even though they worked their longitudes chiefly by the laborious method of "lunar distances." In order to fix the meridian of Rat Island, in the harbor of Rio de Janeiro, Bellingshausen and six of his subordinates figured more than two thousand such operations. The accuracy of most of the Russian positions has been confirmed right up to our own time. Further evidence of skillful navigational technique is found in the corrections to the Flinders chart of part of the east Australian coast. No less accurate were measurements of mountain heights taken with the sextant. Lazarev, commanding the *Mirnyi*, made the altitude of Mt. Egmont, New Zealand, to be 8232 feet, which is less by only 28 feet than that obtained in the latest computations. It is characteristic, moreover, that figures recorded by Bellingshausen nearly always erred, if at all, on the conservative side.

The two vessels were unfortunately not equal sailers, the *Mirnyi* being consistently slower than the *Vostok*, which under favorable conditions attained a speed of 10 knots or thereabouts. Coming into the wind to wait for the *Mirnyi* was an all but daily occurrence throughout 527 days at sea over a track of 57,000 miles. Perhaps the highest praise that can be given to the Russian navigators is to note the fact that the two vessels very rarely lost sight of each other, and then for no more than a few hours. The *Vostok* proved to have many technical imperfections. The hazards encountered, including several hairbreadth escapes from destruction, did not spare the vessel leakage and other damage that would have deterred a less resolute leader from continuing his explorations.

Relatively little is directly known about the life of Bellingshausen, but the character and ability of the man shine out through the mainly matter-of-fact record. He was absorbed in the duties of his calling, exact in his personal routine, cautious, even overcautious, in assertion but generous in praise of his associates. In his zeal for the welfare of his crew he equaled Cook. Professor Debenham refers to "rumours of an incredible number of lashes awarded as punishments," but there is not a hint in the journal that makes this seem probable. Everywhere the commander appears as a kindly gentleman who had the welfare of

all hands constantly in mind and who dealt as justly with primitive aborigines as with his own men. Only once during the voyage did Bellingshausen find it necessary to repel savages by a show of force, and in this instance a single Russian marksman was ordered to fire, if possible, so as to produce only a flesh wound in the leader of the attacking islanders.

As a recorder, Bellingshausen lacked the warmth and color of his countryman Kotzebue, but he greatly bettered the dryness of Kruzenstern. The bulk of the narrative is not inspiring as literature, yet it is relieved by frequent passages that are memorable for their style no less than for their content. After months at sea, the commander was charmed by the exquisite singing of New Zealand land birds, "which sounded like harpsichords and flutes." The beauty of Tahiti stirred him almost to the point of rhapsody. Perhaps, by the way, it is not elsewhere recorded that at the date of the Russian visit Pomare, the Tahitian king, was personally engaged in translating an English Euclidean geometry into the native Polynesian! Nor is the author lacking in ironic humor, as is illustrated by the comment on the missionaries' neglect of the Australian blacks, who lacked resources, as compared with the attention bestowed on "other people in the Pacific Islands, whose soil God had blessed with fruitfulness and the sea surrounding them with treasures."

Regarding the meeting of Bellingshausen with Nathaniel Palmer at the South Shetlands, it is at least apparent that the Palmer legend—true or false—can hardly be traced back to direct testimony of the Russian commander. Bellingshausen's report of the interview, which occupied not more than an hour on January 10, 1821 (Old Style), off Deception Island, is casual, objective, and palpably honest. It certainly gives no hint of the significance attached to it in sources set down by others and mostly at much later dates.

Finally, it is as a record of a very wide range of natural phenomena that the full translation may serve its most useful purpose. In the past, the natural-history results of the Russian voyage have generally been compared unfavorably with those of Captain Cook's voyages. It is therefore no less gratifying than surprising to find that Bellingshausen himself possessed an unsuspected aptitude for significant and even brilliant observation and generalization. In this respect his text is worthily supported by the drawings of Mikhailov, an academician of the Imperial Academy of Fine Arts, whose plates amply confirm the identification of many organisms mentioned in the journal. It was intended that the expedition should include two German naturalists. They failed to join the vessels at Copenhagen, however, and the commander, to his frequently expressed regret, had to proceed without them.

Bellingshausen noted, and set down with a detail that is highly meaningful to a present-day zoologist, the zonal predilections of seals, whales, Cape pigeons and related petrels, tropic birds, flying fish, and other organisms. In numerous instances he shows himself to have been a better naturalist than those responsible for the translation. In the Hakluyt text, for example, the sighting of "the first tropical bird" north of Rapa Island in the Pacific means nothing, but the Russian original includes generic and specific Latin names that tie the observation to the tropic bird. Similarly, a clear and useful reference to "divers"(diving petrels) in latitude 62° 04′ S., longitude 68° 16′ E., is obscured by the addition of a gratuitous editorial footnote that states: "This seems to be a case of faulty identification; there could have been no ducks here." As regards the "biting cormorants" reported on low Polynesian isles, it is possible that both the Russians and the translators have chosen the wrong noun. *Baklan* does, indeed, mean "cormorant," but there are no cormorants in the Central Pacific, and the described behavior identifies the birds as boobies.

Bellingshausen published the first unmistakable descriptions of Arctic terns in their wintering quarters among the South Polar ice floes. He made careful observations on marine luminescence, seaweed, the freezing of saline water, the methods of sealing at Macquarie Island, the use of the tourniquet by Melanesians in the treatment of snake bite, the latitudinal distribution of lightning, the incidence and brightness of the aurora australis, the illusion that fog increases swell, and the "square pupils" of the eyes of penguins. If his insight as a naturalist had been only slightly greater, the finding of eggshells and feathers in the stomachs of giant fulmars shot from shipboard in latitude 68° 30′ 19″ S., longitude 80° 46′ 51″ W., might have taught him that a polar continent was to be sought just beyond the horizon!

In the field of meteorology, Bellingshausen's records substantiate earlier and scantier delimitation of the border between the outflowing polar winds and the westerlies. When his southward progress was checked by ice, he confidently turned northward to 61°–62° S. in order to pick up fresh and favorable winds for his eastward circumnavigation. Beyond 55° S. he found that southerly winds meant clear weather, whereas winds with a northerly slant invariably brought cloud and fog, and usually precipitation. In the austral summer (March) the parallel of 43° S. marked the approximate boundary between roaring westerlies and benign seas.

The Russian commander's hypotheses on Pacific insular arcs and the growth of atolls were, as the editor points out, remarkably shrewd generalizations to have originated with a naval man of a period before the profound depths of the ocean basins were suspected. The most notable of all his scientific contributions, however, is based upon observations in the Sargasso Sea, where, incidentally, his experiments showed that an "ordinary plate" became lost to sight when lowered in the peerlessly clear water to a depth of 168 feet.

Bellingshausen's interpretation of sargasso weed takes precedence over all others. The first statement of the modern point of view is generally credited to Meyen, in 1834.[3] The Russian account, however, was written on May 27, 1821, and was published in 1831:

"Travellers and naturalists differ in their opinion about these growths. Some think with Humboldt that the weed grows on submerged rocks and shoals, and being torn away by fish and mollusca, rises to the surface. Others hold that it is carried thither by the stream from the Gulf of Mexico. I do not think that either opinion is well founded—Humboldt's, because the weed is found in a part where the depth of the sea is more than 350 fathoms and at such depths it is well known that all growth disappears, and because it is further improbable that mollusca and fish would continue throughout the course of centuries tearing off such a quantity of seaweed in the same identical area extending over 1000 miles. Judging from the freshness of the pieces, I cannot agree with the theory that the seaweed is brought by the stream from the Gulf of Mexico. The distance would be 3000 miles, and the nearest shores are those of the Cape Verde and Azores Islands distant 840 and 1050 miles respectively.

"As we did not find on these fresh pieces even the slightest signs of a fractured root, I have come to the conclusion that this weed probably grows on the surface of the sea, without any connection with the bed of the ocean, and that the water in that area has the property of providing food for this weed, which forms a link between the ordinary fixed growths and the floating seaweed. I have already mentioned that it consists of separate pieces, but at various points the waves, winds and currents collect it in large masses."

[3] F. J. F. Meyen: Reise um die Erde . . . in den Jahren 1830, 1831 und 1832, 2 vols., Berlin, 1834–1835.

A GERMAN ATLAS OF EPIDEMIC DISEASES*

GAYLORD W. ANDERSON

ALTHOUGH wartime medical research in Nazi Germany seems to have been practically sterile of significant accomplishments, one result of considerable interest to geographers and epidemiologists alike has come to light in the form of the Seuchen-Atlas—an atlas of epidemics or of contagion. The scope of the atlas, the nature of its subject matter, and the quality of its production assure for it a significant place in medical and geographical literature.

The Seuchen-Atlas is a product of the German Army Sanitary Corps, designed to portray the medical hazards of areas for which military operations were planned. The thinking that prompted the preparation of the atlas is clearly set forth in the foreword, signed by Dr. Handloser, surgeon general of the Wehrmacht, as follows:

"In no previous war that the German nation and German people have fought to preserve their existence have their soldiers been forced to fight in so many different areas or countries of the earth as at present. The illnesses that confront our troops in the areas they traverse are accordingly more varied and therefore more important and more dangerous. In order to develop proper methods of combatting, and if possible of destroying, these endemic or epidemic diseases, it is necessary to know their distribution (*Krankheitsraum*). The present Atlas of Epidemic Diseases conveys this information. Its medical-geographical maps portray the present situation; its geographical-medical or geomedical maps show the dynamics of spread. The Atlas of Epidemic Diseases was developed by very close collaboration between the Military Medical Academy and the Hygienic Institute of the Friedrich-Wilhelm University in Berlin. It should furnish a worth-while medical contribution to military planning. At the same time it is a happy beginning of a new line of research in German and European hygiene.

"Military necessity prevents the general public distribution of the atlas or of its several sections at the present time. It is therefore planned that it be given free only to military establishments and to the German university institutes, which will use it in the training of medical students for their future service with the army."

The concept of the important relationship between medical hazards and the success of military operations is further developed by Dr. H. Zeiss, who served as editor of the Atlas. His introduction is equally worthy of quotation:

"Knowledge of the medical topography and medical geography of a region or a country is just as important as that of its physical geography in the planning and conduct of a military operation. Soil, flora, fauna, and inhabitants—that is, the entire biogeographical picture—are of importance to the soldier. Whether he conquers the country in order to seize and hold it or takes it and passes through it to seize another area, he is brought into closest contact with its total life, its plants, animals, and men. He cannot ignore these even during the most violent struggle, whether in the deployment preparatory to battle or during victorious conquest. Whether the soldier marches and fights in a healthful area (*Gesundheitsraum*) or in a region of disease (*Krankheitsraum*) depends on the terrain and its plant and animal life. It is therefore the task of the sanitary corps to remove the dangerous features

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* Seuchen-Atlas. Herausgegeben im Auftrag des Chefs des Wehrmachtsanitätswesens von . . . H. Zeiss. Justus Perthes, Gotha, 1942–1945.

of regions of disease, or if this is not possible, at least to reduce the danger. Both tasks depend on medical geography. Just as the staff and officers overcome and remove the obstacles of terrain and water that have been exploited by the enemy as a means of defense in the combat area, so has hygiene the same task of overcoming and removing the epidemics that exist or may be developing in the area. Just as the soldier in battle changes the terrain, so must the hygienist often do the same in order to make the character of the land useful in the struggle against epidemics. Every time he does so he alters its biogeographical character and therefore its maps. Without maps maximum achievement is not possible.

"The chief value of a military map lies in the fact that it serves as a basis for appraisal of a situation. Just as the staff gains from the maps of the country ahead a certain advance picture of the relationship of the battle to the physical geography and its effect on man and weapons, so for the fight against disease hygiene must prepare a similar preview of the medical geography and the conditions of endemic and epidemic diseases. Only on such a basis can the disease situation be appraised.

"The decision of the High Command will not infrequently be influenced by medical and scientific labors and research expressed in the form of such maps. The object of the Atlas of Epidemic Diseases is, therefore, to protect the German Army from damage by hidden enemies."

The reasoning set forth above seems to have been the same as that which prompted The Surgeon General of the United States Army to establish a Medical Intelligence Division to prepare sanitary studies of all parts of the world, and the Navy to make highly specialized studies of certain regions.

The Seuchen-Atlas was published as a series of six folders, the first of which is dated late in 1942, the last in 1945. It consists altogether of 217 pages (11 by 9 inches) of text, including 70 black-and-white maps and graphs, and 57 colored plates. These plates, most of which are 19 by 13¼ inches when unfolded (a few are larger), contain a total of 68 maps. For ease of identification the maps and their accompanying text were assigned to the following eight groups and numbered accordingly: I, General Maps; II, Near East; III, Transcaspian Area; IV, Eastern Europe; V, Baltic Region; VI, Central Europe; VII, Mediterranean Area; VIII, North and West Africa. In the following list of contents the Roman numeral before each title refers to this classification, the Arabic numeral to the sequence of topics within each group.

PARTS 1 AND 2

I	1	Plague Reservoirs of the 1st and 2nd Order in Europe, Western Asia, and North Africa, 1921–1941.
II	1	Occurrence of Plague in the Near East, 1917–1941.
IV	1	Plague in Southeast Russia, 1877–1927.
I	2	Tularemia Epidemics in Europe, Western Asia, and North Africa, 1921–1941.
II	2	Distribution of Malaria Mosquitoes in the Near and Middle East.
II	2a	Occurrence of Malaria and Distribution of Malaria Mosquitoes in Turkey.
IV	2	Occurrence of Malaria and Distribution of Malaria Mosquitoes in Caucasia.
II	3	Disease-Carrying Vectors (Other Than Malaria Mosquitoes) in the Near East. Yellow-Fever Mosquitoes—Sand Flies—Ticks.
II	4	Amebic Dysentery in the Near East.
II	5	Leishmaniasis in the Near East.
II	6	Leprosy in Iran.
II	7	Ankylostomiasis and Bilharziasis in the Near East.
II	8	Distribution of Rainfall in the Near East.
II	9	Population Density in the Near and Middle East.

PART 3

I	6	Paratyphoid A in Europe, 1902–1939.
I	8	Distribution of Sand Flies (Genus *Phlebotomus*) in Europe.
III	1	Occurrence of Malaria and Distribution of Malaria Mosquitoes, Transcaspian Area.
III	2	Sand Flies and Ticks as Disease Vectors in the Transcaspian Area.
III	3	Leishmaniasis in the Transcaspian Area.
III	4	Population Density in the Transcaspian Area.
IV	6	Leprosy in Southeast Russia and the Transcaspian Area.

PARTS 4 TO 6

Introduction: Geomedicine of the Mediterranean Area.

The Mediterranean Area as an Epidemic Region

I	7	Paratyphoid C in Europe and the Mediterranean Area.
VII	1	Mediterranean [Undulant] Fever in the Mediterranean Area.
VII	2	Occurrence of Malaria and Distribution of Malaria Mosquitoes in Spain and Portugal.
VII	5	Leishmaniasis in the Mediterranean Area.
VII	6	Leprosy in the Mediterranean Area.
VII	6a–c	Leprosy in Sicily, Sardinia, and Palestine
VII	7	Ankylostomiasis and Bilharziasis in the Mediterranean Area.
VII	7a	Ankylostomiasis in Italy.
VII	8	Distribution of Yellow-Fever Mosquitoes as Disease Vectors in the Mediterranean Area.
VII	9	Distribution of Ticks as Disease Vectors in the Mediterranean Area. Relapsing Fever in the Mediterranean Area.
VII	10	Distribution of the Group of Typhus Fevers (Rickettsial Infections) in the Mediterranean Area.
VII	10a	Typhus in Spain, 1939–1942.
VII	11	Typhoid Fever in Spain and Portugal.
VII	12a	Trachoma in Spain.
VII	14	Distribution of Rainfall and Isotherms in the Mediterranean Area.
VIII	1–3	Yellow Fever in Africa.
VIII	4	Population Density of the Region of the Atlas Mountains.

PART 7

Introduction: Medical Cartography and Epidemic Control.

Eastern Europe as an Epidemic Region

IV	1a	Occurrence of Plague and Distribution of Squirrels West of the Lower Volga.
IV	1b	Distribution of Squirrels in Southeast Russia and in the Transcaspian Area.
IV	4a	Tularemia Epidemics in Southeast Russia, 1926–1942.
IV	8	Occurrence of Worms among the People in Caucasia.

The Mediterranean Area as an Epidemic Region

VII	4a	Occurrence of Malaria and Distribution of Malaria Mosquitoes in Greece.
VII	12	Distribution of Trachoma in the Mediterranean Area.
VII	13	Distribution of Poisonous Snakes in the Mediterranean Area.

PART 8

Introduction: Problems and Methods of Medical Cartography.

I	3	Pandemic Spread of Asiatic Cholera, 1934–1943.
IV	9	Distribution of Rainfall and Isotherms in Eastern Europe.
V	4	Distribution of Rainfall and Isotherms in the Baltic Region.
VI	1	Distribution of Trachoma in Central Europe.
VII	3	Occurrence of Malaria and Distribution of Malaria Mosquitoes in Italy.
VII	4	Occurrence of Malaria and Distribution of Malaria Mosquitoes in Southeastern Europe.
VII	4b	Occurrence of Malaria in Albania.
		Supplemental Maps: For VII 3 Control of Malaria in Latium. For VII 4 Malaria Mosquitoes in Southeastern Europe.

PART 9

Eastern Europe as an Epidemic Region

IV 4 Tularemia Epidemics in Eastern Europe, 1926–1943.
IV 5 Typhus in Eastern Europe.
IV 10 Population Density in Eastern Europe.

The Baltic Region as an Epidemic Region

V 1 Poliomyelitis Epidemics in the Baltic Region, 1938–1941.
V 2 Bornholm's Disease in the Baltic Region.
V 3 Leprosy in the Baltic Region.
V 5 Population Density in the Baltic Region.

From the regional viewpoint the Atlas is of considerable interest as a possible clue to the thinking of the military and medical staffs. Northwestern Europe is completely ignored except for the Baltic area, for which only five maps were prepared. The lack of attention to this region may well be attributed to a realization that health problems here differ but little from those of Germany itself. Only slight attention is given to Spain and Portugal, and none to Siberia. The Atlas concentrates on the Mediterranean area (24 maps), Eastern Europe (13 maps), and the Near East (10 maps) and includes maps extending as far east as India and as far south as Uganda. It is interesting to note that the first and second folders, released late in 1942 and in 1943 respectively, concentrate on the Near East, the Transcaspian region, and Eastern Europe, whereas the folders of later 1943 and 1944 concentrate on the Mediterranean. The first of the Baltic maps appears in the 1944 folder, the rest in 1945. One cannot escape the feeling that the timing was in all instances a bit too late for much training or instruction of medical personnel as to the hazards of the area of immediate military concern or for the intelligent planning of measures to combat local medical problems.

The list of contents shows that special emphasis has been placed on diseases known to have a limited geographical distribution, especially those spread through the medium of insects. The full contemplated scope of the Atlas is not apparent. That not all the maps that were planned were published is shown by the omission of some of the Arabic numerals. What other studies were to be undertaken is not indicated, but there are obvious omissions that might have been in preparation at the end of the war.

The base maps used for the colored plates are reproductions in subdued colors of standard German maps, showing a moderate amount of terrain detail. Superimposed on these in bold colors and symbols are the disease data—the distribution of diseases or of the vectors that cause them. Most of the maps portray a static situation of present occurrence, though on a few an attempt has been made to show direction and speed of spread. For some areas there are maps of rainfall distribution and population density. Even though many of the maps are encumbered with a rather impressive array of detail, they are easy to read. Special mention should be made of the use of small pie graphs to show the relative importance of various types of malaria in certain regions and the use of small bar graphs to show the distribution and relative importance of different types of intestinal worms. The quality of the printing gives no suggestion of preparation in a country that was at the time suffering from shortages of manpower and material.

The text accompanying the maps is concise, but its usefulness is lessened by the omission of a bibliography. The reader is given no clue whatsoever to the sources of the data and their probable reliability.

Worthy of special note are the sections on general principles of medical geography and on geomedical methodology. It is not mere chance that the emphasis in these sections is placed on cartography. Dr. Zeiss quotes Adolphe Armand's writing of the last century to the effect that "topography is to medicine what geography is to history." He envisions a medical map as "a prognostic instrument in the hand of the hygienist provided it is read with understanding and skilled critical sense." Geomedicine is defined as "that branch of medical science which concerns itself with the investigation of the space and time relationships between the occurrence of disease and terrestrial phenomena." The sections on "Medical Cartography and Epidemic Control" and "Problems and Methods of Medical Cartography" are worthy of careful study by all students of epidemiology or cartography.

The Atlas was prepared by a staff of about twenty-eight senior officers drawn very largely from the universities and working under the direction of Dr. H. Zeiss and Dr. H. J. Jusatz,[1] with cartographic direction from Dr. B. Carlberg. The reviewer cannot help commenting on the willingness of the German Army to assign a large staff of senior officers to a task of this character, whereas the major burden of comparable work in the American Army had to be carried by personnel to whom the Army refused to accord so much as field rank and among whom it refused to include officers with geographical training.

The Seuchen-Atlas constitutes a distinct contribution to the field of medical geography or geomedicine. This field, so much neglected in the United States, has been developed chiefly by the Germans. Heretofore, however, most of their publications have been of a descriptive or narrative character. After the Nazi conquest they assumed a political tone, with special emphasis on *Lebensraum*. The present work is free from political ideology aside from the brief reference in the foreword. It is a straightforward scientific contribution, valuable for the factual material it contains and the methods of portrayal it utilizes. It is a unique volume in the field of geomedicine, of great value to both epidemiologists and geographers.

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[1] Articles by Drs. Zeiss and Jusatz appearing in geographical periodicals include the following: Heinz Zeiss: Die Notwendigkeit einer deutschen Geomedizin, *Zeitschr. für Geopolitik*, Vol. 9, 1932, pp. 474–484; *idem:* Medizinische Kartographie und Seuchenbekämpfung, *Petermanns Mitt.*, Vol. 90, 1944, pp. 41–43; Helmut Jusatz and Hermann Flohn: Geomedizin und Geographie, *ibid.*, Vol. 83, 1937, pp. 1–5; and H. J. Jusatz: Die geographisch-medizinische Erforschung von Epidemien, *ibid.*, Vol. 86, 1940, pp. 201–204.

AMERICAN GEOGRAPHICAL SOCIETY

The December Meeting

The regular monthly meeting of the American Geographical Society was held on December 17, 1946, at the auditorium of the Engineering Societies Building, 29 West 39th Street, Dr. John K. Wright, Director of the Society, in the chair. Mr. Martin Bovey spoke on "The Lure of New England," illustrating his lecture with exquisitely artistic natural-color motion pictures.

The January Meeting

The Annual Meeting of the Society was held on January 21, 1947, at the auditorium of the Engineering Societies Building, 29 West 39th Street, President Roland L. Redmond in the chair. Mr. Redmond briefly outlined some of the salient features of the Annual Report of the Council for 1946, published in full in this number of the *Geographical Review*. Dr. Robert L. Pendleton, professor of tropical agriculture and soils, The Johns Hopkins University, then addressed the Society on "Rural Siam." He illustrated his lecture with lantern slides showing various important types of vegetation, crops, cottage industries, methods of transportation, and the like in all parts of the kingdom.

The February Meeting

The regular monthly meeting of the Society was held on February 18, 1947, at the auditorium of the Engineering Societies Building, 29 West 39th Street. Dr. John K. Wright, Director of the Society, opened the meeting by making two announcements, "one," he said, "with regret, the other with pleasure.

"The first is that Mr. Redmond has resigned as President of our Society. Most of you probably know that he has recently been elected to the presidency of the Metropolitan Museum of Art, a high honor both for him and, indirectly, for us. I have been closely associated with Mr. Redmond for the last nine years. One could not ask for a more ideal President. It has been a source of constant satisfaction and joy to work under his wise, progressive, and understanding guidance. The staff feel fortunate and happy that he is not making a complete break but will remain a member of the Council.

"The other announcement is that Dr. Richard Upjohn Light has been elected our new President. It gives me great pleasure to tell you this, even as it gave me sorrow to bring you the news of Mr. Redmond's resignation. The staff all sincerely admire Dr. Light, and we rejoice that he is to be our leader."

Mr. Redmond then presented Dr. Light to the Fellows of the Society with the remarks printed on pages 175–177 of this number of the *Geographical Review*. Dr. Light responded as follows:

"Mr. Redmond: During your term you brought to the affairs of the Society an inspiration that cemented the organization in its tasks. You were the tenth president of the Society, and I should like to recall to your mind some of the notable events that took place in your presidency. The number of Fellows increased from 3500 to 4600; the library added 20,000 books, and the map collection 60,000 maps. Thirteen volumes of the *Geographical Review* were published; sixteen monographs appeared, more than half of which represented pure research. Six expeditions were undertaken, four to the Yukon Territory, one to Alaska, and one to the Sierra Nevada de Santa Marta in Colombia. The Millionth Map of Hispanic America was brought to completion, and you will be interested to know that 57 out of the

total of 107 sheets were completed while you were President. I could not possibly list all the productions of the Society during this period, but you were directly instrumental in forwarding several new ventures, including the highly successful Map of the Americas on the scale of 1 : 5,000,000, the pioneer effort in building up an Atlas of Diseases, and putting the resources of the Society at the disposal of the Army, the Navy, and the State Department during the war. It should be a matter of public record, I believe, that some 45 different government agencies made use of the library and map room during the war period. Finally, 16 gold medals were awarded by the Society.

"Thirteen years ago, standing on this platform, your predecessor, Dr. Finley, said:

" 'Mr. Redmond, our new President, belongs to the new age in which geography, as I have many times recalled, is bringing the human race into what I call planetary consciousness. He has made the work of this Society his first avocation and has given as generously of his time, his means, and his interest as if it were his profession.'

"His words were a prophecy. You have truly given of yourself to the Society."

Thereupon Dr. Light took the chair and introduced the lecturer of the evening, Lieutenant Colonel John D. Craig, who spoke on "The Philippines—Then and Now." Colonel Craig dealt chiefly with conditions in the Philippines before Pearl Harbor, particularly the rising Japanese menace in the educational field and in business. He showed two magnificent motion pictures in color, illustrating various aspects of the landscape and of the life of the different peoples—their customs, clothes, and economic enterprises—the dramatic events of the American invasion, and the results of the destruction of Manila by the Japanese.

Death of Mr. Howland D. Ralphs

The Society regrets to record the death of its former office manager, Mr. Howland D. Ralphs, on December 9, 1946, at the age of 83 years. Mr. Ralphs joined the staff in 1900 and served the Society with devotion until his retirement in 1933. He shouldered many responsibilities in connection with the rapid growth of the institution—its removal in 1902 to the house on West 81st Street and nine years later to the present quarters, and the subsequent rapid enlargement both of its membership and of its program of publication.

Death of Miss Elsa Rowell

The Society regrets to record the death of Miss Elsa Rowell on December 27, 1946. From 1916 until the day of her death Miss Rowell was a member of the library staff, in charge of the collections of periodical and serial publications. During her years of service the library more than doubled in size, the most notable increase being in the collections under her charge. Her careful and zealous work contributed greatly to this development. A person of gentle charm and courtesy, she is much missed by her colleagues on the staff and by the many visitors whom she unfailingly helped.

Our April Contributors

Mr. Higbee, senior agronomist in the United States Department of Agriculture's Office of Foreign Agricultural Relations, is at present assigned to collaborate with the Guatemalan Ministry of Agriculture, in which he heads the Division of Agronomy at its Instituto Agropecuario Nacional. In the past he has served as consultant in tropical crop production at agricultural research centers in Brazil, Peru, Ecuador, and Nicaragua. "The River is the Plow" (*Scientific Monthly*, June, 1945) is a delightful genre picture of the Amazon. "The Agricultural Regions of Guatemala" is a chapter from a book he is preparing on Guatemala.

military service, 1944–1946. He was professor of archeology and director of the Archeological Section, University of Cuzco, 1942–1943. He is now anthropologist in charge of the Colombian Division, Institute of Social Anthropology (Smithsonian Institution), and at present he is in Popayán participating in a cooperative enterprise to train Colombian anthropologists. He is the author of "An Introduction to the Archaeology of Cuzco" (*Peabody Museum Papers*, Vol. 27, No. 2, 1944) and "Inca Culture at the Time of the Spanish Conquest" (*Bur. of Amer. Ethnology Bull. 143*, Vol. 2, 1946, pp. 183–330).

DR. NUTTONSON is research director of the American Institute of Crop Ecology. He initiated the agroclimatological studies of various countries and the establishment of their North American climatic analogues during his wartime association with the large-scale plant-introduction activities of the Agricultural Rehabilitation Division of UNRRA (see also *Science News Letter*, Jan. 13, 1945). DR. KÜCHLER, assistant professor of geography at the University of Rochester, received his training at the universities of Frankfort on the Main and Munich and has spent several years traveling in Europe, South America, and the West Indies. His special interest is biogeography.

DR. MALIN, professor of history at the University of Kansas, has written on various phases of the agricultural history of the Middle West. His most recent publications are "Dust Storms, 1850–1900" (*Kansas Hist. Quart.*, May, August, November, 1946) and "Essays on Historiography" (Lawrence, Kans., 1946; one of the essays is entitled "N. S. Shaler on the Frontier Concept and the Grassland"). On the advent of Hitler to power DR. RAWITSCHER left Freiburg to organize the department of botany in the University of São Paulo, Brazil. Since then his own researches have been mainly in the ecological field.

DR. SPENCER has returned to the University of California at Los Angeles as assistant professor of geography after a period in India and China during the war when he served with the Office of Strategic Services. The present article is a result of his long personal interest in the cultural geography of China. DR. KISS is assistant professor of geography at the University of Michigan. He received his training at the universities of Budapest and Paris and at the School of Political Science in Paris (see also *Geogr. Rev.*, Vol. 37, 1947, p. 143).

DR. MURPHY is on the Council of the American Geographical Society, and he is a Contributing Editor of the *Geographical Review*. DR. ANDERSON is Mayo professor and director of the School of Public Health, University of Minnesota. He received the decoration of the Legion of Merit for his wartime service as director of the Divison of Medical Intelligence of the Office of The Surgeon General. He is co-author of "Global Epidemiology" (1944).

ANNUAL REPORT OF THE COUNCIL

February 7, 1947

To the Fellows of the Society:

The following report prepared by the Director on the activities of the Society for the year 1946 is published by order of the Council.

H. STUART HOTCHKISS
Chairman

To the Council of the Society:

This report summarizes in customary fashion the work of the Society in 1946. Instead of the usual preamble commenting on this work, it seems appropriate to call attention to the principal problems confronting the Society.

At no time has the scholarly and scientific prestige of our institution stood higher or the national and international value of its work been more widely understood or more sincerely appreciated. We have a staff of outstanding professional ability and technical skill and a library and map room that are recognized as containing the most comprehensive and conveniently organized and catalogued collection of geographical books and maps in the country. These assets are solid and substantial and justify an optimistic outlook. However, in order to function effectively, the Society requires adequate space and sufficient funds.

Without radical and costly alterations to the building it will soon be impossible to house the rapidly growing collections and provide office space for the staff, and at the present rate of expansion additional space will have to be secured elsewhere within a few years. The matter of funds is even more disturbing. As the Council well knows, the widespread notion that the Society is a "rich" institution is both false and pernicious. Unless ways can be found to increase our revenues, a radical curtailment of research and publication will be inevitable in the near future, precisely at the time when public interest in geography is growing apace and the need for its sound exposition is increasing commensurately. The Council, well aware of the gravity of the situation, is making a systematic investigation of the Society's actual and potential policies with respect to research, education, publications, and membership. In order that this study may lead to the adoption of a program that should assure the Society's continued existence and growth, the support and counsel of the Fellows are essential.

THE GEOGRAPHICAL REVIEW

The contents of Volume 36 of the *Geographical Review* are largely derived from wartime activities of geographers. The surface and weather conditions of the Greenland icecap are correlated with transarctic flying, and the Marshall Islands are described in relation to transpacific aviation. The impact of the war on South Sea islands is discussed in terms of the problems facing the native peoples and their administrators; the Army farms and gardens of the Southwest Pacific are considered not only as an emergency project but in their implication for the future welfare of the natives and for possible settlers. A British geographer who participated in the Normandy invasion and campaign analyzes the geographical factors that entered into the course of events; an American geographer gives a picture of the coal-mining region of the Ruhr. The channeling of English geography into the war effort is depicted by the American geographer who set up the Map Division of the OSS in London, and the development of the terrain model that proved a vital link in the planning of large military operations is described in a lavishly illustrated article. Research, writing, and publication were carried on to an astonishing degree in the occupied countries; a glimpse of this "fecundity through ordeal" is given for France. The part German geography played in the war is also dealt with.

A distinguished Brazilian geologist-geographer sums up the status of his country's mineral wealth. A confrere in soil science, inspired by the Thornthwaite climatic classification, works out a new formula and applies it to the state of São Paulo. An agricultural economist explores the potentialities of Bolivia's *Oriente* for the present population and for colonists from overseas. Planning projects for the Caribbean envision development of the tourist trade, and in this connection attention is called to possibilities in the little-known Cayman Islands.

The documentary value of the aerial photograph is illustrated in the views of desert trails

of Atacama seen from the air. In the January number the Society reported on the completion of its Map of Hispanic America on the Scale of 1 : 1,000,000.

From Turkey comes a contribution to the hydrography of the Bosporus, and from South Africa a study of the Orange River in relation to irrigation schemes. Recent changes in the political-administrative divisions of the U.S.S.R. are outlined and mapped. Alaska, New Zealand, and southern France figure in other articles, and also the role of plants in geography, historical aspects of rural and urban settlement, river-drainage anomalies, map projections, and geographical nomenclature.

Because of the direct connection between dental health and the fluorine content of water supplies, this subject was chosen as pilot project for the Society's proposed Atlas of Diseases. The first report, published in the April number of the *Geographical Review,* with an insert map in color, was widely distributed and was received in a most gratifying manner. Great interest was also displayed in a report on the Westchester-Fairfield area originally selected as a site for the permanent seat of the United Nations.

LIBRARY AND MAP COLLECTION

The Society suffered a sad and severe loss in the sudden death on December 27, 1946, of Miss Elsa Rowell, who had been on the library staff since March, 1916.

During the year 612 books, 467 pamphlets, 645 complete volumes of periodicals (7122 parts), 11,810 maps, 83 atlases, and 740 photographs were added to the collections, which now number 117,756 volumes of books and periodicals, 23,523 pamphlets, 144,194 maps, 2365 atlases, and 29,563 photographs. To the various catalogues 19,415 cards were added.

The continued effort to acquire foreign materials published during the war years was rewarded by the receipt of large numbers of periodicals, especially from Sweden, the Netherlands, Italy, Switzerland, Finland, and France. Normal communications with Germany are not yet open, but numerous books, a few valuable series (such as *Petermanns Mitteilungen* and the *Geographisches Jahrbuch*), and certain German and other European maps and atlases have been received through participation in the Cooperative Acquisitions Project of the Library of Congress.

Again in 1946, as in 1944 and 1945, more maps were received than in any previous year, the vast majority in the form of gifts from agencies of the United States and certain foreign governments, notably the Army Map Service, the Hydrographic Office, the Coast and Geodetic Survey, the Geological Survey, the Army Air Forces, the Library of Congress, the Survey of India, the Geographical and Cadastral Institute of Spain, and the Geodetic Institute of Denmark. The sincere thanks of the Society are due to these, and also to the other agencies of our own and foreign governments, the commercial firms, and the private individuals whose generous gifts were too numerous to list.

Duplicates of books from our collection were sent to the University of Cracow and also transmitted in considerable quantity to the American Book Center at the Library of Congress for distribution to European libraries devastated by the war. Duplicates of maps were donated to the National Library of China, the Geographical Society of Lima, the Library of Congress, and Columbia University.

We have continued our cooperation with the Association de Géographes Français by furnishing references for the 1940–1944 and 1945–1946 volumes of the *Bibliographie Géographique Internationale.* Volume 9 of the Society's mimeographed bibliography, *Current Geographical Publications,* has now been completed.

NEW BOOKS AND CARTOGRAPHY

No new books were published by the Society in 1946, primarily because the editorial staff had been occupied with wartime duties during the preceding years. Substantial progress was made, however, in the preparation of several works for publication in 1947 and early 1948. These are a completely revised edition of J. K. Wright's "Aids to Geographical Research" (of which the first edition appeared in 1923), to be published for the Society by the Columbia University Press in the spring of 1947; a collaborative work by American and British geographers and demographers to be entitled "Land, Life, and Livelihood in Europe"; a collaborative work on the world geography of petroleum; a volume by Professor N. J. Padelford on the Rhine region; and the scientific results of the Louise A. Boyd expeditions to northeast Greenland in 1937 and 1938.

The Society's cartographic staff was employed during the year primarily on the compilation and drafting of the two sheets to cover the United States and northern North America of the Society's Map of the Americas, 1 : 5,000,000. These were essentially completed at the end of the year, and the finished map will appear in 1947. Considerable work was also done on the revision of selected sheets of the Map of Hispanic America on the Scale of 1 : 1,000,000.

OTHER RESEARCH ACTIVITIES

Studies in the field of photogrammetry were continued during the year by Mr. O. M. Miller, involving among other things work for a government department and collaboration as chairman of the Committee on Map Sketching from Aerial Photographs of the Division of Geology and Geography, National Research Council, in the preparation of a manual.

Early in the year Mr. William O. Field, Jr., rejoined the staff as research assistant after a three-year leave of absence for military service. Mr. Field is carrying forward a comprehensive project of studies of changes in the glaciers of southeastern Alaska, in collaboration with the Research Committee on Glaciers of the Section of Hydrology of the American Geophysical Union, of which committee he is vice-chairman (see the *Geographical Review*, Vol. 37, 1947, p. 159).

The first report on the pilot project for the Society's proposed Atlas of Diseases was published in the April number of the *Geographical Review*. This was a study by Dr. Anastasia Van Burkalow, research assistant on the staff, of fluorine in United States water supplies.

COLLABORATION IN OTHER ENTERPRISES

Again it is gratifying to note the collaboration of the staff in the scientific work of other organizations. Mr. C. B. Hitchcock served as chairman of the United States Advisory Committee on American Cartography and as a delegate for the United States government and representative of the Society at the Fourth General Assembly of the Pan American Institute of Geography and History in Caracas. Mr. O. M. Miller served on the Board of Direction of the American Society of Photogrammetry; his collaboration with the National Research Council and that of Mr. W. O. Field, Jr., with the American Geophysical Union have already been mentioned. Miss Nordis Felland was elected national chairman of the Museum Group of the Special Libraries Association, and Miss E. L. Yonge served as chairman of the Geography and Map Group of the New York Chapter of that organization and attended the meetings at Boston in June. Mr. R. R. Platt represented the Society on the Advisory Committee of the United States Board on Geographical Names and on the Division

of Geology and Geography of the National Research Council. Dr. J. K. Wright served as chairman of the National Committee of the United States of the International Geographical Union, and as president for 1946 of the Association of American Geographers; Dr. Wright, Mr. Hitchcock, and Mr. Miller attended the annual meeting of the association at Columbus, Ohio, in December.

LECTURE PROGRAM

The speakers and titles on the Society's program of lectures delivered at the regular monthly meetings during the year were as follows: January 22, Mr. Harrison Forman, "Report from Red China"; February 19, Mr. Charles P. Mountford, "Australia's Stone Age Men"; March 19, Dr. Trevor Lloyd, "Modern Greenland"; April 23, Mr. Lewis N. Cotlow, "Amazon Jungle Tribes"; November 19, Colonel Gerald Fitzgerald, "Aerial Photography's Contribution to Geographical Knowledge"; December 17, Mr. Martin Bovey, "The Lure of New England."

ELECTIONS OF COUNCIL MEMBERS

During the year three former members of the Council, who had resigned on account of military service, were re-elected: Mr. William Hale Harkness as Domestic Corresponding Secretary, and Messrs. Franklin Dexter and Oliver B. James as Councilors.

FELLOWS

The number of Fellows on December 31 (including persons who had signified their desire to join but were still awaiting formal election) was 4648, of whom 10 were Benefactors, 5 Patrons, 189 Life Fellows, and 28 Sustaining Fellows.

JOHN K. WRIGHT
Director

ELECTION OF OFFICERS AND COUNCILORS

At the Annual Meeting of the Council held on February 7, 1947, the following-named gentlemen were elected to the offices designated:

		Term to expire in
President	Richard U. Light	1948
Vice-President	Frederic C. Walcott	1950
Treasurer	R. McAllister Lloyd	1948
Domestic Corresponding Secretary	William Hale Harkness	1950
Recording Secretary	Franklin Dexter	1949
Councilors	Hamilton Fish Armstrong	1950
	Isaiah Bowman	1950
	Thomas D. Cabot	1950
	Roland L. Redmond	1950
	J. Clawson Roop	1950
Chairman of the Council for 1947	H. Stuart Hotchkiss	

GEOGRAPHICAL RECORD

NORTH AMERICA

THE GREAT PLAINS SHELTERBELTS. In May, 1934, when wind-whipped dust from drought-stricken areas in the Great Plains settled over Washington, D. C., President Franklin D. Roosevelt found an opportunity to establish a tree-planting program for that region. This program had a double objective: protection of exposed soil and crops and of communities, and work relief.

The plan received wide publicity. Some exaggerated claims were made by enthusiastic writers, and the idea was established in the minds of many people that one wide, unbroken belt of trees would be planted from Canada almost to Mexico to form a great wind barrier. Because of the unfavorable natural conditions in the distressed region, these claims raised considerable controversy among foresters and others. However, those acquainted with the region knew that trees would grow there; for scattered through parts of it were many groves and fence rows of trees successfully planted as a result of earlier legislation and earlier planting programs.

The work, directed by the Forest Service, progressed over a wide area. Millions of trees were planted on sites, chosen with attention to favorable soil and moisture conditions, adjacent to the cultivated lands to be protected. There evolved a series of broken-belt plantings of about ten tree rows each, averaging half a mile in length. Often a similar planting joined at a right angle. Prevailingly the plantings were set out as barriers to winds moving from the north and west. Within the zone of planting, which extends from the Canadian border to central Texas, the multiple-row plantings are scattered over the landscape. Hence, instead of the great national tree barrier of the popular concept, they are windbreaks for individual fields and farms.

It was appropriate that ten years after the project had started the Forest Service should assign E. N. Munns and Joseph H. Stoeckeler, both highly qualified, to make an appraisal of the results. The result of their thorough and well-organized field study is published under the title "How Are the Great Plains Shelterbelts?" in the April, 1946, issue of the *Journal of Forestry*. The writer of this note would like to add that a two weeks' study of the project in Kansas and Nebraska in last October confirmed the favorable impressions derived from the report.

Plantings were made primarily to break the force of the wind and thus protect adjacent crops and land, and species and planting systems were selected accordingly. Each planting was designed with shrub rows at the borders and trees of increasing height toward the center, so that a shed-roof profile would develop as the plants grew to maturity. In the outer rows, shrubs and trees of low-branching species were used, set close together, to seal off the wind. Spacing was planned so that in five to ten years the crowns of the trees would close, shading out competing ground vegetation and producing forest soil conditions; both these results were essential to the survival of the trees.

The first measure of the success of the project was to determine how many of the trees lived. From a careful sampling made in 1944 covering more than 3 per cent of the 220 million trees planted it was found that of these belt plantings, then averaging almost 6.5 years in age, 78.4 per cent could be rated good or better and only 10.4 per cent were un-

satisfactory. Weighted averages for the 17 deciduous-tree species used in the belts showed a survival of 69.3 per cent at the age of 6.2 years, and a height of 12.6 feet and a crown spread of 7.4 feet at that age. Comparable averages for the 11 conifer species used showed that 55.4 per cent of the trees had survived to the age of 6.3 years and had developed in that time to a height of 4 feet and a crown spread of 2.7 feet. Cultivation of the young planting for 4 to 6 years had made the greatest contribution to success. Protection against livestock and rodents was necessary.

Results with all 44 of the tree and shrub species studied, including both hardwoods and conifers, were analyzed in detail to appraise the value of each species for the section of the Plains where the planting had been done and to determine the relation of trees or shrubs of that species to others planted next to them. The resulting information has value as a guide in replanting and in making new plantings. It was observed, for example, that Russian olive unbalances a belt when placed in an outer shrub row as in Nebraska and Kansas.

The benefits of windbreak planting are considerably greater than the difficulties and disadvantages, such as land taken out of crop production. In addition to protecting crops and reducing wind erosion, it leads to various minor benefits, such as improving the landscape and increasing bird and game populations, and also to possibilities of nut and fruit production. No reference is made to influence on climate, since this study was limited strictly to appraisal of the existing plantings.

The authors indicate that the project has resulted in wider appreciation of trees in the Plains region. The declaration that "Plains forestry must not be allowed to die out with this effort" will not go unheeded. The Soil Conservation Service, for example, is carrying on as far as resources permit and is adjusting to the wide range of local needs the concept of Plains forestry so extensively established.

In sum, then, "the Shelterbelt Project has been a success." It is making the Plains a better place in which to live.—C. B. MANIFOLD

MISSOURI RIVER BASIN STUDIES. Under agreement with the Bureau of Reclamation and as part of a program for the development of the Missouri River Basin, the United States Geological Survey is issuing a series of maps showing the mineral resources of the region. These are entitled "Missouri Basin Studies."

The first study, "Mineral Resources of the Missouri Valley Region," published in 1945, is a set of four maps. Each sheet, 38 by 48 inches, covers the entire Missouri River drainage basin (about one-sixth of the area of the United States) on the scale of 1 : 2,500,000. The base map, which is the same for all the sheets, includes the geologic formations, shown by color tints and patterns, and structure contour lines. In this way the relation of the various types of mineral deposits to geologic formations and structures can be conveniently studied. Part 1, "Metallic Mineral Resources," shows the chief mining districts, the minerals they produce, and the locations of mills, smelters, and refineries and gives summaries of production. Part 2, "Nonmetallic Mineral Resources," shows the locations of nonmetallic mineral deposits. Part 3, "Fuel Resources," shows the locations of oil and gas fields, oil-shale and coal deposits, pipe lines, and refineries and gives production figures for coal, oil, and gas. Part 4, "Construction Materials," shows the locations of deposits and of processing plants. The main purpose of these maps, in connection with the development of

the region, is, as announced by the Survey, to show the locations of areas of present or potential mining activity that may be considered potential users of electric power.

Other studies issued in this series are preliminary maps of Colorado, North Dakota, South Dakota, Wyoming, and Montana, each on the scale of 1:500,000, showing the locations of sand and gravel deposits; and a map of Wyoming, 1:500,000, showing construction materials and nonmetallic mineral resources by patterns in color on a gray base map. Included on the last map is a short text describing the major occurrences and uses of the resources mapped.

UNITED STATES GEOLOGICAL SURVEY INVESTIGATIONS OF STRATEGIC MINERALS AND OF OIL AND GAS. Intensive studies of strategic mineral deposits and of oil and gas areas, undertaken on an expanded scale as part of the war program of the United States Geological Survey, are still being carried on. The results, issued as preliminary maps and charts, constitute an important contribution to our knowledge of the geology of parts of the United States, both because of their own content and because in most cases they have printed on them a brief descriptive text, often supplemented by structure sections, stratigraphic sections, and a bibliography. They are being made available to the public a few months after the completion of the field reports.

The Preliminary Map series of the Strategic Minerals Investigations consists of large-scale geologic maps, usually in black and white and sometimes with accompanying text. One of these, for example, is a map of the Yellow Pine area in Valley County, Idaho, one of the largest domestic producers of tungsten ores from 1942 to 1945, the second-largest producer of mercury in the United States in 1943, and the source of more than half our domestic antimony ores from 1938 to 1945. Other regions studied and mapped are the vanadium region of southwestern Colorado and southeastern Utah, which is our chief domestic source of radium and uranium as well as of vanadium, and the Arkansas bauxite district, our largest reserve and the producer of more than 90 per cent of all bauxite mined in the United States.

The Oil and Gas Investigations, which seek to delimit broad areas that are favorable for exploration, have been carried on in California, Oregon, the Rocky Mountain States from New Mexico to Montana, many parts of the mid-continent region from Texas to Michigan, the Southeastern States, and the Appalachian region. Emphasis is placed on the thickness of oil-producing formations, changes in facies of these formations, and boundaries of producing or potentially producing zones. Results are being issued in two forms. The Preliminary Charts, of which some 25 have been published to date, consist of columnar sections and a brief text on the stratigraphy and the oil and gas possibilities of the region. Usually there is also an index map or a small-scale geologic map. The Preliminary Maps, on the other hand, of which more than 60 have been published, are large-scale geologic maps. Geologic formations are shown by patterns, usually overprinted in green on a black base that often includes contour lines. In some cases subsurface structural contours or oil and gas pools are shown in other colors. A text printed on the sheet describes the geology and the oil and gas possibilities of the region.

For the country as a whole, the Survey has issued a map of "Oil and Gas Fields of the United States" (1946) on the scale of 1:2,500,000. This map, in two sheets, each 52 by 42 inches, shows the oil and gas fields developed to March 1, 1946, oil and gas pipe lines completed to that date, and major refining centers.

EUROPE

A NEW SWISS PERIODICAL. The first number of *Geographica Helvetica,* organ of the Geographisch-Ethnographische Gesellschaft Zürich, made its appearance in January of 1946. The new publication, a quarterly, supersedes both the *Mitteilungen* of that society and *Der Schweizer Geograph*, formerly the journal of the Geographische Gesellschaft Bern.

Of the twenty major articles contained in the four numbers of Volume 1, eight deal with Switzerland, among them "Die Landeskarte der Schweiz 1 : 50,000" by Karl Schneider (No. 1), "Cols alignés et cols en série dans les Alpes" by Paul Girardin (No. 3), and "Die Rarner Schattenberge" by Fritz Jaeger and Walther Staub (No. 4). There are also several articles dealing with other parts of the world, such as "Der Süden der Vereinigten Staaten" by Hans H. Boesch (No. 1) and "Le Brésil, Pays d'immigration" by Maurice-Ed. Perret (No. 2); several of a more general nature, such as "Géographie humaine et problèmes contemporains" by Charles Burky (No. 1) and "Das System der Geographie und die Dezimalklassifikation" by Ernst Winkler (No. 4); and one concerned with geographical education, "Zukunftsaufgaben des Geographieunterrichts unserer Mittelschulen" by Henri Rebsamen (No. 1).

A brief section of notes and news and reviews of current books of geographical interest are included in each number. The format is pleasing and the illustrative material well reproduced.

THE SWISS EMERGENCY CULTIVATION PROJECT, 1940–1945. Complete agricultural readjustment is needed in many European countries today. In "Das schweizerische Anbauwerk, 1940–1945" F. T. Wahlen (*Neujahrsblatt Naturf. Gesell. in Zürich,* No. 148 [*Vierteljahrsschrift,* Vol. 90, Suppl. No. 5], 1946) gives a detailed account of one readjustment project—the Swiss "Emergency Cultivation Project." However, although the method of the "Anbauwerk" can be analyzed and the results surveyed, it is still too soon to make a final evaluation of the direct and indirect effects.

Fortunately, the Anbauwerk did not have to test its ability to cope with a complete lack of food imports, though Swiss commercial statistics, available once again, show that prolongation of the war for another year would probably have reduced Switzerland to a state of virtual isolation. As it was, the decrease in imports assumed frightening proportions during the war years. The total of imported food supplies and forage in 1944 was a mere 20.4 per cent of the 1939 total, as the following figures show (computed in carloads of 10 tons; hectoliters and pieces per ton converted):

YEAR	CEREALS	FRUITS AND VEGETABLES	GROCERIES	FOOD SUPPLY AND FORAGE CROPS, TOTAL
1939	114,471	34,917	26,796	204,555
1944	15,800	7,029	8,082	41,879

One of the immediate goals of the Anbauwerk was the large-scale expansion of two chief "substitute food products," potatoes and vegetables, and cultivation was promoted by all possible means. Also, every effort was made to prevent establishment of quotas for these so-called "*Ausweichnahrungsmittel*" and to keep them off the ration list. Vegetable production, which before the war had amounted to 25,000 carloads a year, increased to 45,000–60,000 carloads in the last year of the war; potato production increased threefold,

from 61,990 carloads in 1939 to 182,450 carloads in 1944. The ample vegetable and potato supply was as important in its political and social aspects as for its nutritional value. The basic food ration was hardly sufficient for the minimum diet, and therefore one of the chief concerns of the government was to be in a position to satisfy further demands with larger quantities of the "substitute food products." Availability of these products proved to be the most effective method of combating the black market and provided an efficient basis for a reasonable price structure and effective price control. The direct consumption of potatoes by the nonfarming population increased from 75 kilograms per person before the war to 150 kilograms at its end. In addition, potatoes were mixed with grain in bread production to some extent and were also utilized in the manufacture of starch and as feed for cattle.

The contribution of the Anbauwerk to the cereal supply is less obvious. In order to provide feed for farm animals, the cultivation of oats and barley was greatly expanded, as may be seen from the following figures (cultivated areas in hectares; yields in carloads of 10 tons):

CROP	CULTIVATED AREAS		AVERAGE YIELDS		CROP	CULTIVATED AREAS		AVERAGE YIELDS	
	1934	1944	1934	1944		1934	1944	1934	1944
Winter wheat	57,165	79,784	13,262	21,063	Mixed cereals	7,036	11,190	1,639	2,932
Summer wheat	9,608	18,693	1,835	3,683	Corn (maize)	809	4,538	228	1,398
Winter rye	14,242	12,980	3,205	2,998	Winter barley	1,082	11,463	222	2,705
Summer rye	1,400	1,466	239	262	Summer barley	3,086	17,123	549	3,562
Spelt cereals	12,033	19,001	2,744	4,902	Oats	10,145	41,343	2,049	9,550
					Total yields			25,972	53,055

Barley was also used to a large extent in bread production, and in the last year of the war local feed cereals were turned over for public consumption in the form of oat and barley products. Straw supply was another factor solved by the expansion of cereals. Even before the war a great deal of straw had been imported, and during the war years army needs, especially those of the cavalry, increased the demand. At the end of the first year of the Anbauwerk this critical situation had been overcome; 100,000 carloads of straw satisfied army requirements, and there was even a surplus available for use as feed for farm animals.

The goal set for the cultivation of sugar beets could not be attained, largely because of industrial difficulties rather than from lack of suitable land. The building of sugar refineries could not keep pace with the expansion of beet production, and the supply of sugar could be increased by only 30 per cent. Thus sugar remained one of the most strictly rationed items.

The cultivation of rapeseed was one of the most successful projects undertaken. The area devoted to this commodity increased from 8 hectares in 1934 to 8099 hectares in 1944, and in the latter year production reached 15,000 tons. An important finding was that the area planted to rapeseed furnished five times the amount of fat obtained from animals grazed on meadows of the same size. Linseed was also produced in large quantities, both for industrial (*Spindelöl*) and nutritional purposes. Other plants cultivated successfully in considerable amounts were fibers, tobacco, legumes, medicinal herbs, and various spices. Altogether, comparison of the 1939 output of 2300 billion calories with the 3000 billion of 1944 shows a total increase of 34 per cent in the production of nutritive materials.

Whether Switzerland could have put the *Anbauplan* into complete operation had the country been entirely cut off from the rest of the world is an academic question, but one of particular interest to geographers. Lack of food imports would have greatly reduced the industrial activities of the nation and thereby released some 100,000 to 200,000 industrial workers for agricultural service (an estimate based on unemployment statistics of the early thirties). The lack of commercial fertilizers would have necessitated the use of natural ones, but the substitution could have been continued for only a year or so, because most nutritive reserves of the soils would have been depleted in that time. Also, the supply of many types of seeds would have been cut off. The final result of complete isolation would have been a still more pronounced emphasis on the cultivation of potatoes, rapeseed, vegetables, and turnips. This intensification would probably have produced a sufficient quantity of food for both human and animal consumption. Success would have depended in large part on the cooperation of the farmers and workers with the government and the various scientists in charge of the project. The future will show the great advantages gained by the modernization and intensification of Swiss agriculture during World War II.—PETER H. NASH

AFRICA

LIBERIA'S FUTURE. A critical appraisal of Liberia's first century of existence as a republic by Raymond Leslie Buell (Liberia: A Century of Survival, 1847–1947, *African Handbooks, 7,* Univ. of Pennsylvania Museum, Philadelphia, 1947) corroborates and elaborates several of the observations made by Earl P. Hanson in his article on Liberia in the *Geographical Review* for January, 1947 ("An Economic Survey of the Western Province of Liberia," Vol. 37, pp. 53–69). Both authors recognize the serious problem inherent in the present plight of the aboriginal inhabitants. This group, which constitutes an overwhelming majority of the total population, is politically oppressed by the governing Americo-Liberian minority, tax-burdened, and almost entirely illiterate. Native agriculture is in a comatose state, with the result that appreciable quantities of foodstuffs and other agricultural commodities that could easily be produced within the country are imported (for example, rice, cotton, and vegetable oils). From all the evidence it is clear that an economically and politically sound future for Liberia depends to a high degree on the development of an independent, small-farmer, native middle class with opportunity for education and incentive for production.

The rehabilitation program proposed by Mr. Buell centers around a long-term agreement between the United States and Liberia establishing four joint commissions to deal with economic, health, educational, and political problems. Improved diplomatic representation between the two governments and a United States loan of five million dollars are also recommended; the author does not underestimate the grave responsibility of the United States toward Liberia.

CLIMATIC CONDITIONS IN MOZAMBIQUE. From north to south the colony of Mozambique is divided into three distinct climatic zones, each corresponding to about 5° of latitude: the tropical monsoon, the tropical littoral, and the tropical marginal. Scattered over the inland parts of the two more northern zones are isolated areas, some large, some small, characterized by more temperate climate because of their elevation (José de Oliveira Boléo: Elementos para o estudo das condições climáticas de Moçambique, *Moçambique,* No. 44, 1945, pp. 81–128).

In general, the climate of the East African littoral throughout Mozambique and into Natal is influenced by a warm southward-flowing ocean current that moderates the temperature changes normally resulting from differences in latitude. Inhambane, for instance, 124 miles north of Lourenço Marques, has a mean annual temperature only 1.5° C. higher than the latter city; Durban, 234 miles south of Lourenço Marques in Natal, has a mean only 0.6° C. lower—indeed, the mean January (midsummer) temperatures of Lourenço Marques and Durban are the same. Rainfall is seasonal throughout the colony, some three-quarters of the annual precipitation falling in the summer. During the drier months of May to September the index of aridity, based on the De Martonne formula, ranges from less than 20 to 50. However, if the index is calculated for the driest months (June and July), there are only a few parts of the colony where it reaches 10.

A tropical monsoon climate characterizes all of the area between the Rovuma and Ligonha Rivers that has an elevation of less than some 1000 meters. In this part the mean annual temperature is 25° to 26° C. and there is little variation from month to month. The average relative humidity is 70 to 72 per cent. The rainy season occurs during the period of the northeast monsoon (October to April) and the dry season during the period of the southwest monsoon (May to September). Of the annual precipitation total of 1000 millimeters, about 90 per cent falls between the middle of November and the middle of April.

The tropical littoral climatic zone consists of the strip between the Ligonha and the Save. Here the mean annual temperature is 24° to 25° C., the monthly variation 3° either way. Although the relative humidity has an average value of 71 to 74 per cent, it varies greatly. Rainfall is as high as 1250 millimeters in the lower parts but decreases as elevation rises inland. The rainy season lasts from November to April, the dry season from May to October.

A tropical marginal climate characterizes the area south of the Save. The mean annual temperature is 22° to 23° C., the monthly variation 4° plus or minus; there is also a wide diurnal variation. The average relative humidity is 68 to 72 per cent. Mean precipitation ranges from 1000 millimeters in the north to 750 millimeters in the south. November to March is the rainy season; the period from May to August is relatively dry.

A more temperate climate prevails generally in the areas above 1000 meters. Observations made at stations at altitudes of 1050 to 1277 meters indicate a mean annual temperature of 18° to 21° C.; the mean maximum is 23.7° to 28.1° C., the mean minimum 12.7° to 15.4° C. Relative humidity ranges from 64 to 77 per cent. Rainfall ranges from 1000 to 1500 millimeters, generally increasing from the coast to 1000 meters but decreasing above this elevation.

It should be noted that climate must not be regarded as the sole determining factor in judging the adaptability of specific areas of Mozambique for settlement by Europeans, inasmuch as some of the areas that have a salubrious climate are known to be subject to sleeping sickness, malaria, or other diseases.—William E. Rudolph

POLAR REGIONS

AVIATION IN THE WESTERN ARCTIC. The past development, present status, and future possibilities of Arctic aviation are reviewed by Dr. Trevor Lloyd in an interesting article in the second number of the new quarterly journal *Air Affairs* (Arctic Air Transport, Vol. 1, 1946, pp. 218–232).

Largely as a result of wartime development, there are at present four air routes across

the Arctic and sub-Arctic regions of the Western Hemisphere "reasonably well supplied" with facilities for commercial aircraft. The best-equipped of these routes is that known as the Northwest Staging Route, running from Edmonton through Grande Prairie, Fort St. John, Fort Nelson, Watson Lake, and Whitehorse to the Alaskan boundary. This route, which is based on a string of civil airports built by the Canadians in the 1930's and extended through joint Canadian and United States efforts after 1941, was of great military importance during the war as a supply line to our bases in Alaska and as a ferry route for planes destined either for service in the North Pacific area or for delivery to the Russians. The second route, the Northeast Staging Route, as developed for the ferrying of aircraft to Britain, ran from Montreal or Mingan, Quebec, to Goose Bay in Labrador, thence to "Bluie West 1," the United States base near Julianehaab in southwest Greenland, and on to fields in Iceland and Scotland. The installations in the Canadian sections of both staging routes were purchased by the Canadian government in 1944, the United States being reimbursed for all permanent improvements. The so-called "Crimson" route was also created for ferry purposes. Planes from west-coast United States factories moved by way of Great Falls, Mont., The Pas, and Churchill to fields on Southampton Island and Frobisher Bay, and thence to bases in Greenland and Iceland. Planes from the Middle West were flown across Ontario and Quebec to Fort Chimo on Ungava Bay and fed into the main route at Frobisher Bay. The Mackenzie route, running from Edmonton through Fort Smith to Norman Wells, received an impetus when the "Canol project" was undertaken in 1942 but was never completed, and though now used for scheduled flights, it cannot be said to be in first-class condition.

In spite of the increased facilities represented by the routes mentioned, much remains to be done in the way of additional weather observatories, radio stations, and emergency landing fields in the northern regions. In Dr. Lloyd's opinion, it is "doubtful whether much is to be gained at present by moving the existing intercontinental commercial air routes further north," regardless of all that has recently been said and written on the subject of great-circle courses.

It might perhaps be noted that the article here discussed is an excellent exemplification of the policy of the new aviation journal as stated by Mr. William A. M. Burden in its first number: "Aviation has become such a tremendously important factor in world affairs that it must be studied in the broadest possible manner if its potentialities are to be used to the fullest extent for the advancement of the human race. This is the basic thesis of AIR AFFAIRS. To such a study it proposes to devote its pages."

PHYSICAL GEOGRAPHY

WORLD CHARTS ON THE AZIMUTHAL EQUIDISTANT PROJECTION. During the war the United States Coast and Geodetic Survey produced a number of world charts on the azimuthal equidistant projection, centered on various places, including Thule, Greenland; Fairbanks and Point Barrow, Alaska; Kings Bay, Spitsbergen; Tokyo, Japan; Southampton Island, Canada; and Aklavik, Northwest Territories, Canada. Two charts on this projection were also published that do not provide world coverage, one (Chart 3040) centered on Shemya Island and the other (Chart 3041) on Miami. Both are on the scale of 1 : 30,000,000.

Recently (1946), to provide for better air-navigation planning, the Survey prepared for publication by the Army Air Forces a world chart on the azimuthal equidistant pro-

jection centered on latitude 40° N., longitude 100° W. This point is the approximate geographical center of the United States and is near the basic geodetic station at Meades Ranch, Kans., which is of considerable importance because of its relationship to the standard 1927 datum of the United States. On this chart, although the true scaling properties from the center point are obtained at the expense of greater scale errors in other parts, the approximate great-circle route and distance from any part of the United States to any other part of the world can be scaled with a maximum error of only 2 per cent by assuming the straight line on the map to be the great-circle route.

The chart is published on two scales: Chart ZD-10, on the scale of approximately 1:47,400,000; and Chart ZD-11, on the scale of approximately 1:18,300,000. Chart ZD-10 has neat-line measurements of about 34 by 39 inches, and Chart ZD-11, which is in six sections, of about 90 by 98 inches. The latter thus serves as a wall chart for long-range air-navigation planning. On both charts, land areas are tinted in buff and water areas in blue. Boundaries of countries are in dark blue, and names, which have been confined for the most part to those of countries, their capital cities, and the larger metropolitan centers, are in black. On Chart ZD-10 two marginal insets are included for comparative purposes; these are small-scale world maps, also on the azimuthal equidistant projection, centered on London and Tokyo.

Chart ZD-10 is accompanied by a nomograph, which, when used as an overlay, enables great-circle routes and distances to be determined rapidly and with a surprisingly high degree of accuracy.—Albert A. Stanley

GEOGRAPHICAL NEWS

FORTY-THIRD ANNUAL MEETING OF THE ASSOCIATION OF AMERICAN GEOGRAPHERS. The Association of American Geographers held its forty-third annual meeting at The Ohio State University, Columbus, December 28 to 30, 1946. Two and a half days and two evenings were devoted to papers and discussions; because of the crowded program there was no field trip. On Sunday afternoon, December 29, the Department of Geography of The Ohio State University was host at a tea at Pomerene Hall, the Faculty Club. Dr. John K. Wright and Professor John Leighly, president and vice-president of the association for 1946, presided at the sessions, and Dr. Wright gave the presidential address, "Terrae Incognitae: The Place of the Imagination in Geography," at the banquet on the evening of December 30. A map exhibit had been arranged, which included specimens of maps made by various government agencies.

A total of 60 papers were read, and one 90-minute session was devoted to the presentation by Preston E. James of a report of his Committee on Field Studies, which was followed by a lively discussion. No attempt had been made to organize the program so as to emphasize a particular field of geography, with the exception of a special session on physical geography in honor of Wallace W. Atwood. This session, arranged and presided over by Richard Joel Russell, was opened with a discussion by Louis O. Quam of the physiographic history of Estes Park, Colo., a particularly appropriate subject in view of Dr. Atwood's long and active interest in the Rocky Mountain region. Five other papers on geomorphology, including an important contribution on Mississippi River meander belts by Professor Russell, and two papers on soils completed the honorary session.

Several papers on cartography were offered, one of them of unusual interest from the

historical point of view, "Japanese Influences on Western Cartography in the Middle Tokugawa Era," by George Kiss. One paper dealt with geographical nomenclature, and half a dozen were devoted to geographers and their work, including an analysis of the statistical structure of American professional geography in 1943 by W. L. G. Joerg and an announcement of the proposed census of Latin America in 1950 by Jorge Zarur of the Conselho Nacional de Geografia of Brazil. Population and settlement problems were the concern of a number of papers, most of them dealing with areas in the United States and Canada, and political geography was also well represented. The latter group included an original and stimulating discussion by James R. Beck of a technique for evaluating spatial relationships between national boundaries and the limits of culture areas and areas with conditions favorable to economic integration. The paper by George F. Carter describing a geographical approach to the solution of the aboriginal introduction of maize into the United States, the only paper offered in the field of plant geography, aroused considerable interest, as did also C. W. Thornthwaite's discussion of an approach toward a rational classification of climate. The papers on economic geography, nearly a quarter of the total number presented, were mainly concerned with areas in North America; regional studies centered on Latin America, China, and India. It is perhaps worth noting that among the regional papers Shannon McCune's discussion of geographical landscapes in "Korea" surprised his listeners by dealing not with the scene of his earlier studies but with Korea, India, a tiny state in the Central Provinces.

In view of the fact that the program had not been organized around specific topics, an enumeration of the papers according to subject may give a clue to the current interests of American geographers. Economic geography led the field with 14 papers, then came political geography with 8, population and settlement 7, regional studies 6, geographers and their work 6, geomorphology 5, climatology 5, cartography 4, soils 2, geographical nomenclature, plant geography, and historical geography 1 each. Twenty-eight papers dealt with small areas, 20 with regions of greater extent; the remainder were general in character, being concerned with classification, methodology, and so forth. Twenty-two papers dealt with the United States, four each with Canada and Mexico, and 30 with other parts of the world.

The following officers were elected for 1947: Charles F. Brooks, president; Clarence F. Jones, vice-president; and George B. Cressey, member of the council. Guy-Harold Smith and Chauncy D. Harris will continue to serve as treasurer and secretary respectively. Ralph H. Brown was appointed editor of the *Annals*. The University of Virginia at Charlottesville will be host at next year's sessions.

ANNUAL MEETING OF THE AMERICAN SOCIETY FOR PROFESSIONAL GEOGRAPHERS. The annual meeting of the American Society for Professional Geographers was held at The Ohio State University, Columbus, December 27 to 29, 1946. On December 28 the society held a joint meeting with the National Council of Geography Teachers. On Sunday afternoon, December 29, the Department of Geography of The Ohio State University was host at a tea for the society, the Association of American Geographers, and the National Council. An excellent map exhibit included samples of maps of government agencies, topographic models, special Jeffersonian maps, and several rare maps. The Placement Committee of the society was active in rendering service to both employers and employees in the geographical profession.

On Friday, December 27, the program consisted of three panel discussions. John K. Rose was chairman of the morning panel, on "Resources Appraisal and Development Planning—Regional and International." The panel gave examples of what is being done in planning and discussed the organization and problems involved, the geographic contributions, how such contributions may be increased, and the way in which geographers may use the results. Sigismond de R. Diettrich presented a paper on regional resource appraisal in the South in relation to planning; E. D. Eaton described the Missouri Basin Project; Suprakash Ghosh remarked on regional planning in India and the place of geography in the Food and Agricultural Organization of the United Nations; Paul Icke discussed the mineral stock-piling program; and William Van Royen dealt with resource appraisal and resource development.

The second panel, on "Current Map Information," emphasized the functions of map collections and map information offices, cataloguing systems, map acquisition programs, and distribution of maps. The chairman was Walter W. Ristow, and the discussion was led by geographers from several of the principal government mapping agencies.

"The Service of the Geographer in Business and His Requisite Training" was the subject of the third panel, with Eugene Van Cleef as chairman. Stress was laid on the businessman's view of the geographer's opportunities to serve in business, the work of geographers in selected business enterprises, and the training needs of geographers preparing for the business field.

The joint NCGT-ASPG program dealt with geography curriculums. In the morning four papers were presented. Eugene Van Cleef spoke on world events and their implications for the geography curriculum; a paper by Preston E. James presented certain aspects of the developments in the field of geography and their implications for the geography curriculum; a paper by Clarence Olmstead dealt with educational trends and their implications for the geography curriculum. Clyde Kohn gave a paper on "A City Builds a Curriculum."

At a series of luncheon meetings curriculums at various levels were discussed. Ruth Hoffman was chairman of the elementary-school geography section, where J. Russell Smith presented a paper on what should be taught in the elementary schools. Ada M. Shawkey and Howard R. Anderson spoke on geography in the high school. Nels A. Bengtson was chairman of the session on geography in the college, at which Robert B. Hall presented a survey of postwar trends in American colleges and some implications for geography.

The society has the following officers for 1947: Otis Starkey, president; Sidman P. Poole, vice-president; George Deasy, treasurer; E. Willard Miller, secretary. Harold V. Miller was appointed interim editor of the *Professional Geographer*.—E. WILLARD MILLER

SOME NEW PERIODICAL PUBLICATIONS. Several new periodicals of interest to geographers have recently made their appearance. The *Middle East Journal* is a quarterly published by The Middle East Institute (address communications to the editor at 1906 Florida Avenue, N. W., Washington 9, D. C.). The purposes are stated thus: "The United States already has assumed a certain amount of responsibility in such matters as the question of sovereignty in Iran, the defense of the Straits, the admission of refugees to Palestine. Yet to approach these individual problems merely as questions of power politics will not necessarily lead to a full understanding of them or even to an adequate appreciation of their international implications. The future of the peoples of the Middle East no longer will be shaped wholly by the attitude and policies of the powers; forces and factors engendered in and

among these countries themselves—their national consciousness, urge for economic self-determination, cultural conditions, population pressures, regional understandings—must be taken increasingly into account if the Middle East is to attain social, political and economic stability and if the foreign policy of the United States is to be soundly based. To set forth, analyze and evaluate these forces and factors is a principal aim of *The Middle East Journal*." The area dealt with is effectively suggested on the front cover and more specifically defined on the frontispiece map. "For the purposes with which this *Journal* is concerned, they [the boundaries] will be broadly defined. Attention will be centered on the heart of the area: Turkey, Iraq, Iran, Syria, Lebanon, Palestine, Transjordan, the Arabian Peninsula, and Egypt; but not without due reference to closely related peripheral areas, such as the Mediterranean approaches, North and Northeast Africa, Transcaucasia, Afghanistan, India and Turkestan."

The articles in the first number (Jan., 1947) are "The Arab Tribal Community in a Nationalist State" by Afif I. Tannous, "Nationalism in Morocco" by Walter B. Cline, "The Communist Movement in Iran" by George Lenczowski, "The Struggle for Multi-Party Government in Turkey" by Ahmet Emin Yalman, and "The United States and the Problem of the Turkish Straits: A Reference Article" by Harry N. Howard. Sections are devoted to news, documents, reviews, and bibliography.

Pacific Science is a quarterly "devoted to the biological and physical sciences of the Pacific region." It is sponsored by the University of Hawaii (address communications to the Office of Publications at the University, Honolulu 10, Hawaii). Articles of special geographical interest in the first number (Jan., 1947) are "The History, Present Distribution, and Abundance of Sandalwood on Oahu, Hawaiian Islands" by Harold St. John and "The Tsunami of April 1, 1946, in the Hawaiian Islands" by G. A. Macdonald, F. P. Shepard, and D. C. Cox.

The *Quarterly Bulletin of the South African Library* (Cape Town; first number Sept., 1946) has for its aims and objects "firstly, to publish notes, original articles and bibliographies about the wealth of printed and manuscript material in the South African Library, both of general and Africana interest; secondly, to print or reprint works (or parts of works) in the Library that are not easily accessible; thirdly, to describe new acquisitions of interest, and draw attention to gaps in the Library's collections that should be filled; and lastly, to record the output of South African literature of all kinds, in all languages."

Weather is published by the authority of the Royal Meteorological Society (49 Cromwell Road, London, S.W.7). In a foreword to the first number Gordon Manley, president of the society, explains that because of the "increasingly widespread interest in the science of weather manifest in an air age" the society decided to supplement its *Quarterly Journal* with "a new monthly magazine for the exchange and dissemination of information by means of articles, notes and correspondence." Among items in the first number (May, 1946) are reviews of publications on air pollution and the weather and on frost and the fruitgrower, a brief article on the British radiosonde, and "What I Want from the Meteorologist: A Letter to Forecasters." The items, some dozen to a number, are short and lively, and the general tone of the attractive little magazine is set by the striking photographic cover.

In our January issue reference was made to the founding of the British Glaciological Society and its plans for publication of a journal. The first number of the *Journal of Glaciology* (Jan., 1947) has now reached us. The foreword is by H. W:son Ahlmann; the contents include reports on the proceedings at the meetings and the papers read, among them one by the Reverend W. L. S. Fleming on "Professor F. Alton Wade's Antarctic Glaciological Re-

searches," and several short notes—for example, on the snow survey of the British Isles and on avalanche research.

FLINT METROPOLITAN AREA RESEARCH PROJECT. The fact that the United States is becoming increasingly an urban nation has occasioned a need for personnel trained in urban problems and for advances in research techniques and knowledge to cope with these problems. In recognition of this trend, geography has joined with other social-science departments at the University of Michigan in a long-range program of continuing research on urban problems as reflected in the metropolitan area of Flint, Mich. The project, supported jointly by the university and groups in Flint, has two principal objectives: training of graduate students in research, and community service as an outgrowth of that research. Two operating units, one on the university campus and one in Flint, have been organized to promote these objectives. The faculty representative for geography is Professor Robert B. Hall, to whom queries for further information may be addressed.—VICTOR ROTERUS

THE COMMISSION ON HISTORY OF THE PAN AMERICAN INSTITUTE OF GEOGRAPHY AND HISTORY: A CORRECTION. Further details of the proceedings of the Fourth General Assembly of the Pan American Institute of Geography and History are available in an article by Dr. André C. Simonpietri in the *Department of State Bulletin* of January 12, 1947 (pp. 62–67). Dr. Simonpietri asks us to correct a misstatement in the Society's report in the January number of the *Geographical Review* (p. 122). The intermediary of the Mexican government's offer to sponsor a Commission on History was the Instituto Nacional de Antropología e Historia. The chairman of the commission for the interim period is Silvio Zavala, editor of the *Revista de Historia de América* and a distinguished member of the faculty of the Instituto.

WARTIME ACTIVITIES OF THE ROYAL GEOGRAPHICAL SOCIETY. A letter from Mr. G. R. Crone, librarian of the Royal Geographical Society, adds some details to Leonard S. Wilson's "Some Observations on Wartime Geography in England" (*Geog. Rev.*, Vol. 36, 1946, pp. 597–612). "Among scientific institutions our Society was one of the few which did not evacuate its Library and Map Collection from London in 1939, and these were accessible throughout the war. Much use was made of them by government and allied organisations, who often found the subject index of the Library of considerable value, and who borrowed large numbers of books and maps, particularly the Hydrographic Department of the Admiralty, the Directorate of Military Survey, the Interservices Topographical Department, the Geographical Section of the Naval Intelligence Division, and the Ministry of Economic Warfare. We were also glad to be able to assist SHAEF, the Office of the Chief Engineer, U. S. Army, and OSS, and the governments of Norway, Poland, and Belgium. In some instances we were able to provide publications not apparently available elsewhere in this country."

GEOGRAPHICAL REVIEWS

HANDBOOK OF SOUTH AMERICAN INDIANS. JULIAN H. STEWARD, editor. Prepared in Cooperation with the United States Department of State as a Project of the Interdepartmental Committee on Cultural and Scientific Cooperation. Vol. 1, The Marginal Tribes, xix and 624 pp.; maps, ills., bibliogr. Vol. 2, The Andean Civilizations, xxxiii and 1035 pp.; maps, diagrs., ills., bibliogr. *Bur. of Amer. Ethnology Bull. 143,* 1946. Vol. 1, \$2.75; Vol. 2, \$4.25 (obtainable from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C.). 9¼ x 6 inches.

These two volumes, part of a proposed five-volume work, were completed in 1944 and distributed in the summer of 1946. The complete work will embrace all of South America, the West Indies, and a considerable part of Central America. It is to be hoped that when all five volumes have appeared a similar project will be set up for Mexico and Mayan Central America, after which the "Handbook of American Indians North of Mexico" should be revised. The "Handbook of South American Indians" was initially planned by a committee originating (1932) with the National Research Council under the stimulation of the late Baron Erland Nordenskiöld. Responsibility for converting the committee's plan into reality was accepted by the Smithsonian Institution through its Bureau of American Ethnology, and work was begun in 1940, when the project became part of the program of the Interdepartmental Committee on Cultural and Scientific Cooperation.

The editor and guiding force of the Handbook is Julian H. Steward (now professor of anthropology at Columbia University), who traveled widely over South America to obtain firsthand impressions on the possible scope and problems of the project and to arrange for the collaboration of qualified scientists. The first two volumes contain 68 articles by 32 individuals from Argentina, Brazil, Colombia, Paraguay, Peru, and the United States. The important part played, both in planning and in writing, by Wendell C. Bennett, Father John M. Cooper, Robert H. Lowie, and Alfred Métraux is indicated partly by their introductory articles (Bennett, Andean Highlands; Cooper, Southern Hunters; Lowie, Eastern Brazil; Métraux, Gran Chaco) and partly by the fact that these four wrote slightly less than half of the two volumes (719 out of 1548 pages of text). The other more copious contributors were John Howland Rowe, George Kubler, Harry Tschopik, Jr., Bernard Mishkin, Gregorio Hernández de Alba, Junius B. Bird, John Murra, and Gordon R. Willey, the last of whom also assumed responsibility for the final assembling and preparation of illustrations and manuscripts.

The dictionary-encyclopedia system of the earlier "Handbook of American Indians North of Mexico" was not followed, but this is no drawback, since a complete index to the Handbook is to be issued that will include all the synonyms of each tribe. Furthermore, the material in each article is arranged according to a standard sequence, which greatly facilitates location of the information desired for any tribe, group, or region. Among the headings of greater interest to the geographer are Natural Environment, Tribal Divisions, Sources, Subsistence Activities, Houses and Villages, Transportation, Manufactures, and Economic Organization. Numerous illustrations are used—photographs of terrain, vegetation, people, structures, artifacts, and so on, line drawings, and maps—and most of them are well selected and well reproduced. It is a pity that the reproductions of old maps of the

Peru-Bolivia region (Vol. 2, Plates 87–89) could not have been full-page instead of half-page, since many of the place names are difficult to identify. The most original and valuable maps are: Tribes of the Gran Chaco: Locations at the first European contact (Vol. 1, map 4), Tribes of the Gran Chaco: Present-day locations (Vol. 1, map 5), The tribes of eastern Brazil at various dates since the Conquest (Vol. 1, map 7), Tribes and provinces of the Inca Empire (Perú-Bolivia), circa 1530 (Vol. 2, map 3), and Archeological sites of Ecuador (Vol. 2, map 6).

Naturally, in a brief review of two such bulky and compendious tomes there cannot be a critical discussion of the contents. Many of the articles should be subjects for individual review, especially those based on original field work and hitherto unpublished (such as "The Contemporary Quechua" by Mishkin, "The Aymara" by Tschopik, and "Tribes of the Sierra Nevada de Santa Marta, Colombia" by Park) and those providing extensive and new syntheses (such as "The Andean Highlands" and "The Archeology of the Central Andes" by Bennett, "Inca Culture at the Time of the Spanish Conquest" by Rowe, "The Quechua in the Colonial World" by Kubler, and "The Araucanians" by Cooper).

An enormous amount of work has gone into these volumes. The component articles represent the wheat that has been winnowed from the chaff of thousands of articles and books, most of which either are not easily available or are in languages not had by the average English-speaking American anthropologist or geographer. The basic literature (some 10,000 items have been accumulated in the full bibliography for the entire Handbook, for the publication of which no provision has been made) must still be consulted by the specialist, but the Handbook provides an excellent digest of the salient anthropologic elements, and most of the more important sources (both content and bibliographic) are cited. The reviewer does not know the selective criteria that determined the terminal bibliographies in the first two volumes and hence can express only mild surprise that certain works by such men as Raimondi, Von Tschudi, Von Martius, Moisés Sáenz, and Hipólito Ruiz were omitted. There are remarkably few typographic errors considering the total number of words and the languages involved. A few examples are Kroebel for Koebel (Vol. 1, p. 600), 1857 for 1587 (Vol. 1, p. 618), and the commonly encountered confusion in the citing of Jorge Juan and Antonio de Ulloa (Vol. 2, pp. 1004 and 1031). It is a pity that the items in the terminal bibliographies could not have been annotated, or at least the date of the first edition and date of writing (when possible) given consistently.

The two volumes cover respectively the marginal hunting and gathering tribes of eastern Brazil, the Gran Chaco, the Pampas, Patagonia, and Tierra del Fuego and the peoples and cultures of the Andean highlands and associated Pacific coastal lowlands from Colombia to south-central Chile. The presentation is basically a summary of ethnographic information as of the contact period (European discovery, exploration, conquest, colonization, and missionizing), with archeologic background where possible, post-Conquest acculturation, and status as of the latest information in hand. There are few attempts at theoretical interpretation, though naturally such topics as prehistoric chronology, population estimates, postulated origins of peoples and items of material culture (such as cultivated plants), and linguistic affiliations must reflect a certain amount of individual bias and subjective judgment if they are treated to any extent. The reviewer, for example, finds himself disagreeing with some of the statements and conclusions concerning population (Vol. 2, pp. 7, 184 ff., and 334 ff.), but the whole matter of pre-Conquest and colonial populations rests on such unsure

ground that probably there will never be unanimity of opinion regarding it. An outstanding contribution of the Handbook is that it delineates problems and points out lacunae in many types of information.

Reference commonly is made to secondary sources on physiography, climate, and vegetation, but the strictly geographic treatment of South America has been relegated to Volume 5, along with more detailed treatment of linguistics, physical anthropology, and other topics. The use of mean annual temperatures by some writers, loose and popular terminology at times for cultivated plants (for example, Vol. 2, p. 210), and the use of "steppe" (Vol. 1, pp. 381 and 382), of "fox" (*passim;* there are no foxes in South America, only foxlike canines), and of native "melons" (Vol. 2, p. 21) are examples of minor subjects for criticism. The glossary (Vol. 2, pp. 975-978) is in need of revision. Such Spanish words as *corregidor, hacienda,* and *obraje* are defined either too loosely or too strictly considering their usage in Spanish America. The value of a *fanega de tierra,* defined as 1.59 acres, varies enormously according to what is being planted and where (the reviewer has found it to range from less than one hectare to more than six). *Achiote* is definitely Mexicano (from *achiotl*) and not Spanish. *Andén* is perfectly good classic Castilian and not "Aymara (?)." *Cholo* most probably is Indian (Carib or Aymara) rather than Spanish. Incidentally, the reviewer is not yet convinced that the language should be spelled "Aymara" and not "Aymará."

To sum up, the Handbook is an invaluable work that should be in the possession of everyone interested in the anthropology, geography, sociology, or history of South America. Many textbooks in these fields on Latin America can and should be drastically revised in the light of now easily available data.—DONALD D. BRAND

NUEVA GEOGRAFIA DE COLOMBIA: Aspectos político, físico, humano y económico, By PABLO VILA. 358 pp.; maps, diagrs., ills., bibliogrs. Librería Colombiana, Bogotá. 1945. 9 x 6 inches.

Professor Pablo Vila, a native of Catalonia who has lived for almost a decade in Colombia, has written a geography of his new *patria.* In a masterly way he treats the political, physical, human, and economic aspects of the country. He devotes an excellent historical chapter to the Magdalena River, which was for so long the economic life line of Colombia. In the section dealing with agriculture, the backbone of Colombian economy, he reaches the significant conclusion that "technical progress will not be possible without the aid of government credit to the farmer, and without the organization of a producers' cooperative such as exists in the coffee industry." The gradual evolution of the economy is pictured in detail: first a glimpse of the pre-Colombian cultural landscape; then, in proper perspective, the Spanish colonial regime, which constricted the life of the country like a strait jacket; lastly, modern Colombia, with its factories and its railroads, its oil fields and its air service—the whole presented in so authoritative and interesting a manner as to have a lively appeal for the general reader and the social scientist as well as for the student and the classroom. The volume contains scores of richly illustrative photographs and charts, and each chapter (except the first) is accompanied by an exhaustive bibliography, which makes it indispensable to those concerned with Colombian problems. This work, in scope and general excellence, is unique among its kind in the Latin-American world, and geographers of the other republics would do well to use it as a model.—RAYMOND E. CRIST

THE BUILDING OF THE BURMA ROAD. By TAN PEI-YING. vii and 200 pp.; map, diagr., ills. Whittlesey House, McGraw-Hill Book Co., New York and London, 1945. $2.75. 8¼ x 5½ inches.

This little book might well have been subtitled "Afterthoughts of the Engineer." It is a subjective, personal narrative by a professional marine engineer who was drafted early in the Sino-Japanese conflict to build a highway that would link the road systems of China and Burma. It is a very human story, and good reading, from such early remarks as "I always hated the zigzag curves of the Road. My own standard would have been a road as straight as an air line. But we had to compromise with nature" and "So our program was roughly this: to get the Road open, never mind whether it was good or bad; then to improve the Road as much as possible and surface it with gravel; and finally to put in the refinements" to a much later one concerning arrival in a bombed city while preparing to demolish 15 miles of the precious road to hold back the Japanese: "This was the saddest experience of my life. Everywhere were the white clothes that the Chinese wear in mourning as the Westerners wear black. . . . Even nature contributed to the melancholy mood, for the rainy season had begun." These quotations give the tone of the book. The simple map and profile are useful, and the photographs well selected to fit the text. Tucked into the brief account are most of the essential facts about "the Road," along with a good deal of information about Yunnan Province, the habits of the residents, and the trials of road building in a formidable landscape isolated from most of the modern equipment of the world of engineers. The transport historian may deflate the value of "the Road" in defeating the Japanese, and also its future value to commerce. But in the bleak days of 1944 when Chinese and Americans alike, in China, were waiting for the Japanese to be cleared out of northern Burma so that "the Road" might start reducing the scarcities that planes could not remove, its psychological worth was as great as the immense regard that the marine engineer Tan feels for his strangest assignment.—J. E. SPENCER

A CHINESE VILLAGE: Taitou, Shantung Province. By MARTIN C. YANG. xvii and 275 pp.; maps, diagr., ills., index. Columbia University Press, New York, 1945. $3.00. 9¼ x 6 inches.

EARTHBOUND CHINA: A Study of Rural Economy in Yunnan. By HSIAO-TUNG FEI and CHIH-I CHANG. Revised English edition prepared in collaboration with Paul Cooper and Margaret Park Redfield. xviii and 319 pp.; maps, ills., index. University of Chicago Press, Chicago, 1945. $3.75. 9¼ x 6 inches.

These two important volumes by Chinese scholars on two widely separated parts of China have a somewhat related aim but paint similar scenes with very different color and tone effects. It is the present fashion among social anthropologists to produce "community studies" that are microscopic analyses of selected rural villages. Extremely painstaking when fully tailored, they provide the student of the social sciences with a variety and volume of data he never before has had. However, there are dangers in an exclusively microscopic program. Human culture is too complex and varied to permit reasonable application to a broad scene of the findings on any minute portion of society unless such findings are complemented by studies pitched at several other levels of observation, interpolation, and interpretation.

Martin Yang's book is a notable addition to the scanty literature in English on Chinese village life. In the smooth flow of its chapters there is laid out, in beautiful clarity and simplicity, that which makes a small Chinese village tick. The organization is excellent: there are no complex statistical tabulations to confuse the reader, and simple maps present the necessary facts. Photographs would have helped, but the war apparently made them impossible. To geographers interested in China several chapters are important reading: The Village Site, The People, Agriculture, Standard of Living, The Family as a Primary Economic Group, The Rise and Fall of a Family, The Village of Tomorrow. Interwoven with these, such chapters as Marriage, Village Organization, and Intervillage Relations round out the pattern of life in a small agricultural village of North China.

Notwithstanding the excellence of the book in what it does, it is what it does not do that provokes the caution suggested above. There probably is no single village in any country that can be taken as a sample of the entire rural life of that country. The author's choice of a small village near Tsingtao, Shantung, was dictated by the facts that he grew up there and that he was unable to study other North China villages in wartime. Both facts color the book. It touches reminiscence about one's boyhood home, and at times memory dons rose-colored glasses. Nowhere in its pages does a Chinese family really come to grips with the sheer economic facts of life, though without a knowledge of this struggle complete understanding of the position of rural China today is impossible. Perhaps Yang's village was a fortunate exception to the average overcrowded, underprivileged Chinese farm village. In any case, in his miniature China there simply is no agrarian problem; families rise and fall automatically and painlessly as land changes hands, but tenancy and its evils apparently do not exist as elsewhere in rural China. Such a statement as "The lease usually lasts only one year; the rent is low but is not less than thirty percent of the land's net return in the year" shows little appreciation of the grimness of the daily struggle for the many landless and nearly landless Chinese peasants.

Another subject passed quickly by is the role of rural industry and handicrafts. In discussing agriculture the author only briefly indicates that a few men of poor family divide their time between crafts and their plots of land and that necessity does cause this diversion from the life of a cultivator. Elsewhere it is casually admitted that there is a need for more rural-village industry to provide economic opportunity. Rural industry, the problems of new opportunity for the lower economic strata, and allied questions are more important in rural China today than the author indicates.

Across China to the southwest, Hsiao-tung Fei and a group of students, all through the long war, have been working on the varied problems of rural life that show up in Chinese villages of Yunnan Province. Perhaps their wartime economic privations have forced on them too full an acceptance of the theory that all life's problems are solved by an adequate income. Whether or not this is a fair observation, Fei and Chang are occasionally sharp and biting about village life, whereas Yang is always mellow and sweet-voiced.

"Earthbound China" is one of the most important volumes on China to appear in English in some years. It is a study of three small villages near Kunming, Yunnan, with one central problem in mind—"the gradual concentration of landownership." Although this is the central theme, the authors deal in a comprehensive manner with the whole of rural economy. The three villages are of different types, one predominantly rice- and bean-growing, the second having two important rural industries, and the third devoting much attention to truck gardening for a neighboring town.

The volume is one of a series being translated into English and edited from the Chinese texts of studies of Yunnan made by Fei and his fellow members of the Yenching-Yunnan Station for Sociological Research, a series that, when completed, will provide a notable exception to the variety of isolated community studies to which the reviewer objects.

"Earthbound China" is fundamental material for anyone interested in modern China. It provides documentation regarding the causes of the economic and social unrest that has been sweeping China for decades. Proceeding through a critical examination of the basic problem, "How do the villagers in interior China live on the land?" the authors become "in a certain sense . . . the plaintiff for the Chinese peasants." They go further: "Having set forth their [the Chinese peasants'] cause and submitted evidence, we shall then appeal for certain actions, to improve their way of life." Including a village in East China (reported by Fei in "Peasant Life in China," 1939), the authors conclude: "In all four villages the number of poor and landless, that is, of people who cannot depend on their own land entirely for providing a living, is around 70 per cent, or more than two-thirds of the population." Two customary methods of adding income, among villagers—rural industry and specialized agriculture—are held unable to take care of all Chinese farmers, because villages are not always properly situated with regard to markets, transport routes, raw materials, and the like. With land representing the best source of rural income, the only real source of security, the one certain tangible basis for a ready-money loan, and the most prized possession of rural China, there is, today, simply not enough land to go round. "As a result, land transactions are far from being a matter of merely marketing a commodity, but rather represent a struggle for survival" in which one family gets up in the world only by buying the underpinnings from another family at a time of financial reverse, thus throwing the now landless family into the caldron of economic helplessness. Much of rural China is still fighting a losing battle, in rural industry, against the machine, with "the result . . . that China is gradually being reduced to an agrarian country, pure and simple; and an agrarian China is inevitably a starved China."

A summary conclusion is that only in a well planned program of diffused rural industry of a modernized type replacing the vacuum created by the destruction of native rural industry is there a possible solution to the economic insufficiency of the world's most populous country. Perhaps the authors put their case with a little overemphasis, as in the last quotation, but their general thesis is clear, and it is certainly being proved to a considerable degree by time and events inside China. What they urge amounts to government sponsorship of, and leadership in, a program of rural industrialization wisely keyed to the economic programs of the world as a whole.—J. E. Spencer

SAUDI ARABIA: With an Account of the Development of Its Natural Resources. By K. S. Twitchell, with the collaboration of Edward J. Jurji. xiii and 192 pp.; map, ills., index. Princeton University Press, Princeton, N. J., 1947. $2.50. 8 x 5¼ inches.

Mr. Twitchell's engaging little book might have been titled "The Arabia I Know"; for it is the distillation of twenty thousand miles and more of journeyings with a purpose—exploring ancient mine workings from which may have come some of King Solomon's gold; planning the layout of roads where the need is matched by the constructional difficulties; investigating water supplies where "the average annual rainfall is 3.5 to 4.5 inches, except in the Asir mountains and southern Hijaz, where . . . it fluctuates between 10 and 12 inches." At one point the author is installing buoys in Jidda harbor; at another he is examin-

ing a port site at Ras Tanura, on the Persian Gulf. Or he is drill testing for ground water east of Jidda, then leaving his wife to carry on with "a crew of twenty to thirty devout Moslem Najdis" while he advises King ibn-Saud on "the water resources and oil possibilities in his province of Hasa." Or he is putting the Mahad Dhahab (cradle of gold) mine into operation; or studying a dam site for the Wadi Abha in Asir, where, when he made his first visit, "no American and no non-Moslem had ever been." These are some of the activities gleaned from his modest and simple narration.

Mr. Twitchell's Arabian travels began in 1927 when he was engaged by the late Charles R. Crane to carry out various engineering works in behalf of the Imam of the Yaman. In 1931 he was detailed to the service of King ibn-Saud, for whom he has since executed many commissions. He dedicates his book to the memory of Mr. Crane, "the great American whose practical philanthropy was the foundation of the present development of the kingdom of his esteemed friend, King Abdul Aziz ibn-Saud." The arrangement of the book is systematic: chapters on the environment, the political and social development, the position of Saudi Arabia in world economy. The treatment is concise but has color and intimacy, as the reader of "Water Resources of Saudi Arabia" (*Geogr. Rev.*, July, 1944) will appreciate. There are excellent thumbnail sketches of the "vital centers of national life"; for instance, "aloof" Buraida, "believed to be the world's leading camel market," and, in complete contrast, the new oil town of Dhahran, "a bit of the United States transported to Saudi Arabia." There are glimpses of distinctive architectures of the country, such as the "multiple eaves" of Abha, useful protection against the heavy showers that fall in the mountains of Asir, or the "unique, spacious, stone buildings" of Taif built during the Turkish regime. The discussion of proposed roads is interesting, and so is the concluding chapter, which deals mainly with commerce and agriculture and ends on a hopeful note of possibilities; but, with the limelight now focused on King ibn-Saud and the oil resources of his country, special mention should be made of the chapters on the House of Saud and the rise of the Saudi State and that on oil and mines, in the development of which Mr. Twitchell himself had an important part.

A SHORT HISTORY OF ERITREA. By STEPHEN H. LONGRIGG. viii and 188 pp.; maps, ills., bibliogr., index. Clarendon Press, Oxford, 1945. $3.50 (Oxford University Press, New York City). 7¾ x 5 inches.

Brigadier Longrigg's book is a useful addition to the scanty literature in English on an obscure subject. As Chief Administrator of Eritrea from 1942 to 1944 (the territory was taken over by the British in 1941) he was in a unique position to evaluate Italy's administrative record in its Red Sea colony and to forecast the territory's future needs. He would have been more successful in his twofold aim of interesting the general reader and assisting the peacemakers if he had placed greater emphasis on recent developments. Instead, he intentionally limits himself for the most part to the confusing facts and legends of Eritrean history. This is somewhat illogical in view of his admission (p. 175) that the facts of political history are of only limited help in deciding what to do with Eritrea.

In an introductory description of the geographical background Brigadier Longrigg points out that Eritrea's 45,000 square miles cannot be assigned wholly to North, Central, or East Africa, to the Nile Valley or the Red Sea, to Ethiopia or the Sudan. The territory is divided into a south-central plateau bordering Ethiopia, an eastern coastal plain on the Red Sea, a broken hill country in the central north, and a western plain bordering the Anglo-Egyptian

Sudan. This lack of geographical unity accounts for the surprising variety of peoples, languages, and religions in so small a political unit.

After a brief review of the early history of the country, the author traces in greater detail the rise and decline of the Ethiopian monarchy, of whose territory Eritrea was a remote part, from the fourteenth century to the eighteenth. By the early eighteenth century the royal authority had disintegrated to such an extent that a number of subkingdoms, developed partly on geographical lines, were the real centers of political power. One of these, the kingdom of the Tigrai, extended its rule over southern Eritrea after 1725. When, in the nineteenth century, notable chieftains such as Theodore, John IV, and Menelik II were able to re-create the Ethiopian empire, they faced a threat from the Italians, who established footholds in the coastal areas of Eritrea and Somaliland and pushed inward until their defeat in the famous battle of Aduwa in 1896. Menelik II, however, in spite of his victory at Aduwa, agreed to Italian retention of Eritrea, which Mussolini used as a springboard for his conquest of Ethiopia in 1935.

For a British official writing shortly after the cessation of Anglo-Italian military hostilities, Brigadier Longrigg has summarized the Italian administrative record with admirable impartiality. He concludes that the Italians brought to Eritrea "a conception of tranquillity and security never before imagined," along with "a material equipment and modern services far ahead of usual colonial standards." The natives were "on the whole treated . . . with sympathy and goodwill." Taxation was light, and justice was carefully administered. Native land rights were safeguarded, and the native share in the benefit of public services in medicine and agriculture was substantial. Evidence of these improvements may be found in the rapid increase in population from 330,000 in 1900 to 760,000 in 1941.

On the other side of the ledger, the administrative system was bureaucratic and inelastic; standards were low in sanitation and in the prisons; the color bar was enforced, particularly after the advent of the Fascist regime; native schools were few and poor, and the natives were not trained for participation in government. Finally, the author makes it clear that many of the Italian material contributions, especially the fine communications system, were intended to prepare the way for further Italian military aggression.

Poor in resources, Eritrea has always had an adverse trade balance and was a drain on the Italian treasury. Unlike the Italians, the British military administrators made efforts to develop local industry, but Brigadier Longrigg concludes that Eritrea's chief economic hopes lie in its meager agriculture, its inferior herds, and its poor mineral resources.

The author questions Ethiopia's current claim to all of Eritrea. He points out that nearly half of the population are Moslems, who oppose union with Ethiopia. Even among the Coptic Christians of the southern plateau, the only part of the population racially and culturally akin to the Ethiopians, such a union is opposed by most merchants (who want security and order), by a majority of the chiefs, and "by all who value the progress made in Eritrea in the last half-century and contrast its present condition with that of northern Ethiopia." Restoration of Italian rule is opposed by a majority of the inhabitants, though, in the author's opinion, the continued presence of possibly 3000 to 6000 Italians is indispensable for the maintenance of material services already in operation. An independent Eritrea "could not but end in anarchy, or in renewed European control." Finally, Brigadier Longrigg expresses the belief that probably no other European power would be willing to accept Eritrea.

As a solution to the dilemma Brigadier Longrigg boldly proposes a tripartite dismember-

ment of the territory: the Moslem tribal areas in the west and north to be annexed to the neighboring Anglo-Egyptian Sudan; the Dankali country on the southeast coast, including the port of Assab, to be annexed to Ethiopia; and the southern Tigraian plateau, with the connecting central belt extending inland from the port of Massaua, to form a separate "state or province, which should be placed under the sovereignty of the Emperor of Ethiopia but be administered, in his name, by a European power for either a stated or an unstated term of years."—VERNON MCKAY

[Under the Treaty of Peace with Italy her African colonies are to continue under their present administration pending final disposition within one year from the coming into force of the Treaty.—Edit. Note.]

SUDAN GEOGRAPHY. By R. A. HODGKIN. 160 pp.; maps, diagrs., ills., index. Education Department of the Sudan Government, 1946. $9\frac{3}{4}$ x $6\frac{1}{2}$ inches.

This book is intended primarily for the first two years of Sudan secondary schools, but it could be studied profitably by any geographer as an example of method and read for its content by anyone interested in a land that now ranks among the problem areas of the world; for it clearly reveals the variety of internal problems that confront any government whatever the solution of the current political situation (cf. *Geogr. Rev.*, Vol. 36, 1946, pp. 682–683).

The book begins with Khartoum and Omdurman (what makes a capital?). Succeeding chapters take up the Kababish nomads (camels, goats, and sheep) of the northwest; the cultivators of central Kordofan (water supplies); the Nuba region of plains and hills; Darfur and the Baggara (cattle nomads); the grasslands of the Butana (east of Khartoum); the Red Sea hills and the seminomadic Beja; the Gezira and cotton; the Shilluk and a journey to Juba; the land and life of the Azande of southern Equatoria; a year with the Dinka (cattle nomads half of the year, grain cultivators the other half) in the swampy plains south of Malakal; the south and Sudan trade; the coast and Red Sea ports (Suakin and Port Sudan); the Northern Province (irrigation); and a final chapter on the Nile and the Sudan. There are several sketch maps and many delightful little drawings *sui generis*. Appendix I is a vignette of the Sudan quoted from an inaugural lecture by the late Sir Douglas Newbold, which begins: "No one can get to love a country without seeing it properly: all true affection rests upon vision. Vision again rests upon knowledge. . . . Knowledge must pass into vision, that state of mind and heart which does not merely swallow evidence, but changes that evidence into a judgement, an appreciation, a living picture of a country."

LA FRANCE. Part 1, France physique. By EMMANUEL DE MARTONNE. 463 pp.; maps, diagrs., ills., bibliogrs., index. (Géographie Universelle, Vol. 6, Part 1.) Librairie Armand Colin, Paris, 1942. 11 x $7\frac{1}{2}$ inches.

Between 1927 and 1939 twenty of the twenty-three volumes planned to make up the Géographie Universelle were published. The last three volumes, covering France, the native land of the editors and authors, were ready in manuscript in 1939; the volume here under consideration eventually appeared in 1942, published in Paris at what might be called the height of the occupation. [The first half of the second part, "France économique et humaine," by A. Demangeon, has appeared and will be reviewed in the next number of the *Geographical Review*. Edit. Note.]

Considering the inauspicious circumstances of its appearance, the reader's first reaction is likely to be astonishment at the high quality of the paper, the excellent reproduction of the

photographs, and the perfection of the typography. In fact, the volume seems to be fully up to the standard of its predecessors except that the plates do not show quite the clarity of detail found in the prewar volumes.

The geomorphologist, who has the broad definition of physical geography in mind, will not expect to find "France physique" confined to landforms alone; also, since Professor de Martonne is known primarily for his geomorphic writings, it will not cause surprise that the first part, "Le relief du sol," is nearly twice as long as the second part, "Le climat," "Les eaux," "Le tapis végétal." Similarly, fifty-nine plates are devoted to landforms, but only seven to other subjects. This disproportion in treatment may in part be required by the great diversity of topography in France and in part be attributed to the interests of the author.

It is interesting to find that Professor de Martonne treats France under the same regional headings that would probably be used in an American course on the regional geomorphology of Europe. These geomorphic provinces, which are based entirely on structure and topography, are depicted in Lobeck's well-known diagram of Europe and can be readily recognized on any adequate geologic or topographic map of France. The provinces are as follows: the Paris Basin, the Northern Hercynian Massifs (Armorica, the Ardennes, the Vosges), the Central Massif, the Alps, the Jura and the Saône Depression, the Rhone Depression, and the Mediterranean Coast, to the last of which is added Corsica, the Pyrenees, and the Aquitanian Basin. The concluding chapter of "Le relief du sol" discusses the shore lines as a unit, a treatment that in this reviewer's opinion gives a better picture of the varied shore lines of France than the regional treatment would.

Discussion of individual regions is systematic and is well exemplified by the two chapters on the Paris Basin, the historic heart of France, on which the author seems to dwell more lovingly than on the other regions—as any geographer or geomorphologist might well do. An introductory statement delineates the chief features of the Paris Basin briefly but strikingly, and then the boundaries are considered. These are everywhere determined by structural highs in the old Hercynian basement. Four of the highs, those of the Ardennes, the Vosges, the Central Massif, and the Armorica-Cornwall-Wales Massif, which has only recently been separated by submergence, are strong enough for the ancient rocks to outcrop. Here the boundaries are naturally most marked. Between the massifs the continuity of the old rocks is broken at the surface by four saddles, where erosion has not yet exposed the basement. Even here, however, the old rocks are not deeply buried and are frequently seen in small, obscure outcrops, in railroad tunnels, and in mines. Except in the north, where there is a long break between the Ardennes and the Armorica-Cornwall-Wales Massif, the boundary is primarily determined by highlands, for elsewhere the saddles are relatively short. In the north, too, the encircling ring of the Hercynian high is continuous and is marked by the elongate anticline that extends from the west end of the Ardennes through Artois, Boulogne, across the English Channel, and along the Weald into Cornwall. Thus, as De Martonne says, the Paris Basin exceeds the limits of France and of the mainland of Europe. De Martonne has been a strong supporter of the position that any complicated regional discussion must be based on an adequate presentation of the geology. This was true in his earlier volumes on Central Europe in the Géographie Universelle series (reviewed by Griffith Taylor, *Geogr. Rev.*, Vol. 21, 1931, pp. 688–690; Vol. 23, 1933, pp. 153–155) and is also true in this volume on France, as can be seen by his detailed discussion of the geological history of the Paris Basin. The ancient peneplane underlying the sedimentary rocks was not warped into

a basin until the beginning of the Tertiary, and it does not form part of the present topography, though it is found as an exhumed topographic feature in the massifs on the borders of the basin at various places, including the Morvan, where it furnished Davis with his type example of a morvan, his term for a resurrected peneplane. The distribution of the Mesozoic and Cenozoic beds overlying the basement, however, is of great importance for an understanding of the remarkable series of concentric cuestas and lowlands that center on Paris. This distribution is explained in part by the advances and retreats of the great epicontinental seas in which were deposited the widespread Jurassic limestones and the Chalk, in part by Tertiary deposits of marine and continental origin, and in part by warping, particularly between the Oligocene and the Miocene, which allowed irregular transgression of younger beds over older. The structural and lithologic contrasts of the region are then discussed. Drainage development follows, and finally the various subdivisions of the basin are described in detail.

Fifty-three pages are thus devoted to the Paris Basin, more than are given to any other region; the interesting and varied Central Massif comes next with forty pages. It is obvious that in such brief treatment there can be little room for extended discussion of debated points, but within the limits of his space Professor de Martonne has written as useful and enlightening a geomorphic description of France as is likely to be written. With striking phrase and pointed comparison he has brought out the important characteristics of each province in such a way that they will remain long in the reader's mind.

Lack of space forbids comment on the last third of the volume, but for an appreciation of the regional variety and complexity that is France the reader's attention is called to the exquisite maps showing climates (17 types), soils (19), floristic regions (12), and vegetation (27), the last in particular a triumph of draftsmanship.

The geologist or geographer who finds pleasure in the regional aspects of his subject can surely spend many profitable hours with this book and a geologic and topographic map of France. It will serve as an invaluable reference for many courses on the regional geography of Europe.—HENRY S. SHARP

ROCKS AND RIVERS [OF AMERICA]. By ELLIS W. SHULER. xx and 300 pp.; ills., index. [Humanizing Science Series.] The Jaques Cattell Press, Lancaster, Pa., 1945. $4.00. 9½ x 6¼ inches.

THE ROCKY MOUNTAINS. By WALLACE W. ATWOOD. 324 pp.; maps, diagrs., ills., bibliogr., index. (American Mountain Series, Vol. 3.) The Vanguard Press, New York, 1945. $3.75. 9¼ x 6 inches.

THE PACIFIC COAST RANGES. Edited by RODERICK PEATTIE. xviii and 402 pp.; maps, ills., index. (*Ibid.*, Vol. 4.) 1946. $3.75.

In "Rocks and Rivers" Professor Shuler has written an excellent book for the layman, primarily the layman who travels and who wishes to understand and appreciate the landscapes he sees. The book "is an adventure. Geologists, as most scientists, have been afraid to show any feeling for the larger scope, the cultural interest, the wonder of their science." Its further purpose is "to glorify the common phenomena rather than the odd or unusual."

The book treats of the general subject matter of physical geology: the materials of the earth, the processes at work carving the crust, removal of the waste, formation of soils, sculptured lands, springs, caves, sinkholes, natural bridges, wave and shore-line features,

volcanism, glaciation, waterfalls, and so on. The plan is "to introduce each general discussion with a concrete landscape," usually of some scene well known to the traveling public. For example, the representative cave described is in Texas, but mention is made of Mammoth Cave, the Carlsbad Caverns, and other well known caves. The chapter entitled "How the Rivers Crossed the Ridges" notes Thomas Jefferson's early essay at an explanation of water gaps and describes Powell's explorations in the Uinta Mountains and into the Grand Canyon, the Davis cycle of erosion for humid lands, peneplains, and the problems of drainage in the Appalachians.

The 105 excellent and illuminatingly captioned illustrations form one of the most valuable parts of the book. For example, the caption of a scene of the Rio Grande Valley in New Mexico, with three mesas in the distance, describes the cycle of erosion in the area, the reason for preservation of the mesas, and the end result of their denudation. Undoubtedly the photograph most nostalgic for Professor Shuler is Figure 1, taken in 1896 by Marius R. Campbell of the United States Geological Survey from the top of Salt Pond Mountain in southwestern Virginia; for beside Mr. Campbell at the time was the author as a fifteen-year-old boy. It was his introduction to geology.

Unfortunately, from the geographic viewpoint, the chapter on "The Economic Landscape" is approached from the viewpoint of economic geology, and minerals alone are considered worthy of treatment. The book itself, although of value to the professional geographer, provides the traveler or amateur geographer only with the geologic background of the "concrete landscape." It does not attempt to provide a broad cultural background for the layman interested in all he sees, but it does give him a framework of physical geography in succinct form and in a delightful style.

President Atwood's book on the Rockies is written for the student and the tourist. It combines the popular and the scenic, the wisdom of many summers of camping and pack-train trips and the mature judgment of a physiographer and geologist whose scientific life has been devoted to studying the range at first hand from New Mexico to Alaska.

A vivid opening chapter describes a pack-train and mountain-climbing trip from Ouray to the peak of Uncompahgre in the rugged San Juan Mountains of southwestern Colorado. Then, after a description of "opening a field season," the author begins the unfolding of the "mountain drama" and describes it as seen "from the air and from the saddle." A chapter entitled "Understanding Mountain Scenery" is followed by one on "The Art of Camping," then by "Mountains Are Worn Away" and "Mountains Rise Again." The result is good, since the layman, whose first interest is probably to obtain information about camping, hiking, and a pack-train trip, not only is led into appreciation of the scenery with which he may be surrounded but is also made aware of the geologic history of the range, from its inception, through glaciation, to recent sculpturing. The closing chapters, which follow that on glaciation, deal with various well-known and exciting mountain events related to mining, the Indians, ranchers, cowboy songs, and the tourists of "vacationland." A summary chapter on national parks gives the "why" of such parks and a short description of each. An excellent feature of the book is that the Canadian sections of the Rockies are included.

The author says that "this is the first book I have ever prepared for the general reader." The book will undoubtedly fulfill its purpose of informing and educating the reader not schooled professionally in physical geography, and it will do so in a most pleasing manner.

Each chapter in "The Pacific Coast Ranges" is in itself a thoroughly readable essay touching

on some aspect of the Coast Ranges from the southern boundary of California to the Canadian border. The reader cannot help noting the diversity of landscape within the ranges, from the brown hills near San Diego to the lush forests of coastal Oregon and the Olympic Peninsula of Washington, from the irrigated valleys of southern California to "evergreen pasture lands" in the Oregon and Washington littoral, and from the chaparral bushlands of the Mexican border country through the magnificent redwood forests north of San Francisco to the evergreens and permanently snow-covered peaks of the Olympics.

The outstanding chapter, geographically, is that on climate, contributed by Professor Richard Joel Russell. A difficult subject has been handled admirably—treated popularly but with enough statistical and scientific data to be appreciated by the specialist in geography or climatography. An equally difficult assignment, also well done, is the geological chapter, by Professor Daniel E. Willard, who deals with the maze of details of these complex ranges with facile pen and leaves the over-all picture with the layman reader without burdening him with minutiae.

The less technical chapters are contributed by specialists and regional writers, who add to the vividness. Donald Culross Peattie writes of the missions and the wild flowers; Aubrey Drury of the Save-The-Redwoods League depicts the wildlife scene; and Dr. John Walton Caughey contributes chapters on the Indians of the Ranges and California's literature.

"Local color" chapters by regional writers deal with such diverse subjects as the foothill people of San Diego County, the winegrowers of Napa Valley, the mining camps of the Trinity region in northern California, the peoples of the Oregon and Washington ranges, and the lumbermen of the Olympics.

There are bound to be some errors and inconsistencies in a volume whose ten authors possess such different backgrounds. The numerous conflicting figures of maximum Olympic Mountain rainfall are finally adjusted by means of a footnote which states that the exact amount is not known. The most glaring geographical error is the statement on page 189 that the Pacific Ocean "pours its southeast trades against their [the Olympics'] western side."

In sum, "The Pacific Coast Ranges" strikes a popular note that will undoubtedly command for it a wide audience.—Loyal Durand, Jr.

THE BROADLEAF DECIDUOUS FORESTS OF THE PACIFIC NORTHWEST. By A. W. Küchler. *Annals Assn. of Amer. Geogrs.*, Vol. 36, 1946, pp. 122–147.

The Pacific Northwest as defined in Professor Küchler's paper is bounded on the north by the Washington–British Columbia border, on the east by the crest of the Cascade Range, on the south by the Klamath Mountains in Oregon, and on the west by the sea. It is essentially the part of Washington and Oregon mapped by Livingston and Shreve as having Northwestern Hygrophytic Evergreen Forest. A few deciduous trees are widely scattered through the region, but they form forests only in small, isolated spots.

The author compares the climate of the region with that of three other areas in the world where the climatic pattern is somewhat similar—in the western part of the South Island of New Zealand, on the western slopes of the southern Andes, and in Northwestern Europe. In all of these, well-developed deciduous forests hold a dominant place in the vegetation, so that they are in strong contrast with our northwest coast, where conifers are almost completely dominant.

A second comparison brings out the fact that during the Tertiary, as fossil evidence indicates, the northwest coast had a deciduous forest similar to that in eastern North America

and only a small representation of conifers. At that time the deciduous forests in North America must have existed under a wide variety of climates. The author believes that any other assumption would entail changes in the general arrangement of the world's climates that can hardly be conceived. The deciduous forests disappeared in the Northwest during the Pleistocene except for the small remnants that still remain, and the proportion of deciduous to coniferous trees does not seem to have been seriously modified by climatic changes since the retreat of the glaciers.

With these observations in view, the author defines the problem of the anomalous scarcity of deciduous forests in the northwestern coastal area. Evidence is presented to suggest that glaciation in the Klamath Mountains may have been intense at a somewhat earlier date than in the Coast Ranges west of the Willamette-Puget Sound trough, so that the only southward migration route for the pre-Pleistocene deciduous forests was cut off. The result was the nearly complete extinction of these forests as the periglacial climate became more rigorous. To account for their failure to recolonize the region after the Ice Age, the author invokes the theory widely applied in the boreal world by Hultén, that populations of plants which were closely beset by glacial conditions and reduced to small numbers were so depauperated of their potential genetic variability and spreading capacity that they have been unable to regain lost territory. Küchler reaches the conclusion that "the present composition of the forests of the Northwest is therefore not so much the consequence of the prevailing climate. Much rather it results from events in the climatic history since the Miocene era, especially in their relation to location and relief, and their effect on the number of biotypes."

Professor Küchler is to be congratulated upon a well-organized analysis of an intriguing but highly complex problem. His paper offers a good illustration of our failure to find cause for existing phytogeographic phenomena in such environmental correlations as we are at present able to make. He has done what plant geographers continually find themselves forced to do and has taken refuge in "anterior" or historical causes. The modern distribution patterns of species and plant communities can be looked upon, at their simplest, as "conic sections" taken at a point in time. Even if we allowed for precisely regular cones, the behavior of the sections with changes in time would be sufficiently complex; but if we furnish the cones with amoeboid qualities, as we must do, the problem of assigning cause, historical or otherwise, reaches unimaginable complexity.—Hugh M. Raup

CROP PRODUCTION AND ENVIRONMENT. By R. O. Whyte. 372 pp.; maps, diagrs., ills., bibliogr., indexes. Faber and Faber Limited, London, 1946. 25s. 8¾ x 5½ inches.

In "Crop Production and Environment," R. O. Whyte, of the Imperial Bureau of Pastures and Forage Crops, Wales, reviews a large accumulation of literature on plant physiology in relation to environment. The factors of environment, light, and temperature are considered in relation to the processes of "growth" and "development" as the physiologist defines the terms: "Growth is the accumulation of dry matter or increase in size of a plant, development the progress towards reproduction." Studies of the factors of light and temperature are relatively recent: the main body of the literature under review has appeared since 1935, much of the more significant since 1940. The material is gathered from all the major research centers of the world; only Europe under German wartime domination is not well represented. It is worthy of notice that, in spite of the continuation of British war economy,

research and publication of this scope and high quality have been carried on as essential activities.

Problems of growth and development are treated in connection with vernalization, phasic development, hormones, and genetics, and with regard to all of them substantial differences of opinion are evident between Russian and non-Russian physiologists. The reader is constantly impressed by the care with which Whyte states each question, the discrimination exercised in wording the answer, the limitations placed on conclusions, and the warnings given against certain kinds of generalizations that go beyond the facts. All this is particularly welcome to those who are not specialists in biological science. Although a fair working knowledge of plant physiology would certainly be an advantage to the user of the book, the presentation of the main conclusions should be clear to a reader with the minimum of technical equipment.

As modern civilization, in its transit round the globe, has been concerned mostly with the Temperate Zones, problems of light and temperature have attracted less attention than water requirements. The extension of man's activities into the higher latitudes and into the tropics brings these factors into prominence. Plant physiology is giving new significance to them in all environments. With respect to light, plants may be classified as long-day, short-day, and day-neutral. Some plants require long, some short, seasons of a particular day length to grow and to develop toward reproduction. In the tropics, plants live under approximately equal periods of light and dark and nearly continuous high temperatures. Plants of the same genetic value may react quite differently to dissimilar environments, the factors of one region releasing characteristics inhibited in another. Geographical races or strains within the same species of native vegetation may show different responses to light and temperature when moved from one latitude to another. A plant promising in one environment may be a disappointment in another, and the reverse.

Agronomic management is the primary objective to which Whyte's survey is directed: "Crops in which the foliage or the root is the economic end product depend more on growth than on development for their optimal yield. . . . Agronomic practices are generally adapted to ensure that conditions are optimal for those physiological processes concerned in producing the economic returns required, whether of grain or cut green fodder, green vegetables, root crops, green manure, tobacco or timber." Problems of distribution, migration, and adaptation relating to plants living either in natural conditions or in domestication require much rethinking when described in this framework of developmental physiology. To all students of geographical relations, these matters are of direct importance.

The work of the historian, the geographer, and the plant physiologist can and should be complementary in affording a better understanding of the problems of man's relations with the earth. For the present reviewer, a historian interested in agriculture and geography, the discussions of vernalization (cold treatment of seed) and the disagreement among the scientists possess a special interest. At a time when science did not have much to contribute as a guide to the practical agronomist (1866, 1867), the farmers of central Kansas discussed among themselves the effects of wintering on wheat varieties. Winter wheat sometimes could not be planted under conditions that permitted growth before cold weather. It was generally agreed that winter wheat must undergo a wintering process if it was to produce a crop. One school of thought insisted that the seed should be planted, even though it did not grow, because it would thus be subjected to winter conditioning, approximately the equivalent of the effect of cold on the growing plant. They debated the matter of how late in the

season winter wheat could be planted and receive this cold conditioning, either as seed or as growing plant, and make a crop. One variety of wheat, Odessa, an importation from Russia, gained a temporary popularity in the late 1870's, in part because it was said that it would make a crop as either winter or spring wheat. It was through experimentation, observation, and discussion that the hard-winter-wheat belt became an established fact, founded on varieties and cultural practices in harmony with the mid-rainfall environment of the central part of the North American grassland.—JAMES C. MALIN

ICE ATLAS OF THE NORTHERN HEMISPHERE. v and 106 pp.; maps, bibliogr. *H. O.* [*Publ.*] *No.* 550. Published by the Hydrographic Office, United States Navy, under the authority of the Secretary of the Navy, Washington, D. C., 1946. $8.00. 24½ x 24¾ inches.

One's first impression of the "Ice Atlas of the Northern Hemisphere" is of its size: each page is just a little more than two feet square, so that when the atlas lies open it covers an area of two feet by four feet. As one turns the pages, however, one realizes that this atlas is also a prodigious achievement, the result of a vast amount of work. But it is not merely an excellent technical publication: the charts are so expertly and beautifully made that it deserves attention as a fine example of cartographic art.

Dr. John C. Weaver, now of the Department of Geography at the University of Minnesota, deserves credit for the carrying out of this project. It was begun in 1942 by Dr. Weaver and the American Geographical Society under the auspices of the Division of Geography and Cartography of the United States Department of State. It was carried on as a State Department project until the spring of 1944, when Dr. Weaver became an ensign in the United States Navy. Fortunately for the ice project, he was assigned to the Hydrographic Office, where he was able to complete the compilations for the atlas.

This new publication does not follow the traditional classification of ice types according to their origins. On the contrary, the approach is from the standpoint of the kind of information that will be most useful to the ice navigator, and the emphasis is therefore on the classification and distribution of ice as it affects the movement of ships. Five degrees of navigability are recognized:

1. Permanent polar pack, inaccessible to navigation.
2. Unnavigable sea and land-fast ice, occasionally penetrable by powerful icebreakers.
3. Generally unnavigable sea and land-fast ice. Icebreaker assistance normally required, although at times penetrable by heavily built vessels.
4. Sea and land-fast ice generally navigable by heavily built vessels.
5. Sea and land-fast ice generally navigable by unreinforced vessels.

For clarity in the presentation of the material, both by charts and by tables, seven major areas are recognized: (1) Northern Hemisphere, sea ice; (2) Northern Hemisphere, river ice; (3) Grand Banks Region; (4) Baltic Sea; (5) Black Sea; (6) White Sea; (7) Okhotsk Sea Region.

Obviously, much thought has been given to the presentation of the data in such fashion as to make them immediately useful to the ice navigator. Having sailed Arctic waters with that great ice navigator the late Bob Bartlett and others, I can see what a valuable tool this atlas will be in the hands of such men. Everyone familiar with Arctic ice realizes that averages are of little use for the immediate problems of navigation but that extremes are very useful, and this fact has been carefully observed in the presentation of the various data.

The series of charts showing the extreme limits of ice, 1898–1938, will be welcome to all navigators of ships in the Arctic and to those who may plan summer expeditions anywhere in that general region. What Dr. Weaver has done for ice of the sea in attempting to show its limits in a way that will be useful to navigators he has likewise done for river ice by the use of isopleths. Average positions assumed by ice during its advance and retreat are shown for the beginning, the middle, and the end of each month. It will be seen that anyone planning any kind of work in the areas involved will find the data and the charts extremely helpful.

Although this great atlas is designed with reference to its usefulness in navigation, it is much more than simply another tool for the navigator. Any student of ice conditions in the Arctic, no matter what his approach may be, will find the atlas, with its superb tables and extensive bibliography, a necessary part of his equipment. I should be inclined to say that the bibliography is the most comprehensive yet published in this field.

The present publication is the first of its kind, and it is a continuing project. As more data become available either from individuals and institutions or from further exploration, future editions may be expected to become more and more definitive.—L. M. Gould

INTERNATIONAL SEA TRANSPORT. By Sir [Harry] Osborne Mance, assisted by J. E. Wheeler. xii and 198 pp.; bibliogr., index. (International Transport and Communications.) Issued under the auspices of the Royal Institute of International Affairs. Oxford University Press, London, New York, Toronto, 1945. $3.00. 8½ x 5½ inches.

INTERNATIONAL RIVER AND CANAL TRANSPORT. By Sir [Harry] Osborne Mance, assisted by J. E. Wheeler. viii and 115 pp.; maps, bibliogr., index. (International Transport and Communications.) Issued under the auspices of the Royal Institute of International Affairs. Oxford University Press, London, New York, Toronto, 1945. $1.00. 8½ x 5½ inches.

Both volumes are encyclopedic in scope. They contain brief histories of international regulations and agreements, public and private, relating to all aspects of water transport: from international law to the conference system of determining ocean freight rates; from international regulations for prevention of collisions at sea to the international aspects of wage differentials as affecting merchant-marine public subsidies. The growth of international regulation, both by governments and by private agreements, is traced, and each volume closes with a concise summary of the present status of international regulation in its field—a summary that may well form the syllabus or theme for any consideration of the relation of the UN to this specialized problem of water transport, which, after all, is but one aspect of the broad problem of international cooperation and collective security.

"International Sea Transport," after describing briefly the principal shipping conferences and other machinery for regulating maritime commerce, reviews the essentials of public international law, including such topics as definition of "high seas" and "territorial waters," and proceeds to description of the various private types of international regulation: bills of lading, maritime liens and mortgages, and so on. The timely topic of combined air-sea travel is included, though the current problem arising from restriction of American shipowners from engaging in air operations while foreign competitors are permitted to do so is not treated.

A chapter on technical and safety questions develops the history of conventions govern-

ing safety, including load lines, lighting of coasts, and a concise but clear statement of the complex—to the layman—problem of the various methods of tonnage measurement. A chapter on labor conventions is simply a list of the principal conventions.

The greater part of the book is devoted to a consideration of the recent history of the maritime policies of each of the principal seafaring nations; the United States policy is particularly clearly stated, up to the outbreak of the war. The problem of excessive tonnage and the conflicting results of national subsidies on the one hand and international organization for the rationalization of shipping on the other are clearly brought out. The author believes that international commercial problems in the field of sea transport can be largely worked out on the unofficial level by "a separate unofficial body, such as might conceivably originate in an association of Liner Conferences, Tramp Committees and the Tanker Association. The functions of this body need not be limited to questions of allocation and rationalization, but might, when appropriate, include the world aspects of the kind of trade question dealt with regionally by bodies such as the Baltic and International Maritime Conference, including commercial port questions, insurance, etc." Continuity of the wartime collaboration in shipping problems is urged, but fundamentally, the author points out, "there would seem to be no difficulty over sea transport if the major problems of collective security are successfully solved."

"International River and Canal Transport" similarly reviews the history and status of international agreements regulating river transportation but, because the problem is more specialized regionally and locally, takes up the question continent by continent, and separately for each of the principal navigable waterways. Major emphasis is, of course, on Europe. Here, particularly, it is pointed out, the solution is entirely dependent, not on specific agreements or conventions, but "on the readiness of States to discipline themselves in the general interest in return for security and reciprocal benefits under guarantees in which they feel they can place confidence." For Europe, too, the author urges maximum private initiative with the minimum of official interference consistent with coordinated development. He fully recognizes that international regulation of river transport may be much more complicated than that of sea transport because of the necessity of multiple-use development of the inland water resources.

Not the least valuable feature of both publications is the extensive bibiliography, including principally official documents, many of which contain the texts of official regulatory conventions.—Harold M. Mayer

NEW CITY PATTERNS: The Analysis of and a Technique for Urban Reintegration. By S. E. Sanders and A. J. Rabuck. v and 205 pp.; maps, diagrs., ills., index (subject). Reinhold Publishing Corporation, New York, 1946. $8.00. 11¼ x 8½ inches.

This book makes a fundamental contribution to the art of city planning and a major contribution to urban geography. Much of what is presented has been seen before in fragmentary or partial form in the publications of the Federal Housing Administration, the National Resources Planning Board, and various leading city and regional planning associations of the nation. Never before, however, has so comprehensive yet condensed an offering been made that covers not only American but British, Russian, and German city-planning sources. The geographer with casual interest in the urban scene will find much to delight the eye. The serious student will gain an insight into the complex economic, social,

and political circumstances that produced the old, haphazard, unplanned patterns and will be shown the logic and the plans for implementing intriguing "new city patterns."

Of special interest are three series of maps showing the growth of Baltimore, Washington, D. C., and Chicago from their early village-town stage to their present metropolitan stage (Fig. 1). Initial concentration (Charles C. Colby's "centripetal forces") leads to the accumulation of size, with its attendant disadvantages, and this in turn to "explosive" decentralization (Colby's "centrifugal forces"). Interest is also aroused by a plan of a four-block slum section in Manhattan (Fig. 64) showing the high coverage of land surface by shade-casting buildings; by the sweeping, curved streets, widely spaced and tree-shaded houses, and conveniently placed recreational facilities and shopping center of the 3000-family Linda Vista housing project at San Diego, Calif. (Fig. 77); and by a schematic diagram of the Sanders-Rabuck "urban planning objectives" (Fig. 23). This diagram deserves critical examination. It is wheel-shaped, with six thick, spokelike, radiating segments, each compactly containing residential developments of three densities, a secondary business district, convenient residential shopping centers, some heavy industrial terminal facilities, some light industry, and, at the outer ends, slightly detached, a sizable square of land devoted to heavy manufacturing. Between these radiating segments are open, green, wedge-shaped areas, the tips of which with the base of each segment touch the hub containing the central business district, high and intermediately dense residential areas, light industry, and heavy terminal facilities. All this is caught in a spider web of circular and radiating roads and railroads. Such a city would have unobstructed country air and sunlight penetrating to its core, and it would be a healthful and convenient place in which to reside. Furthermore, such a plan would be flexible, for segments could be removed, added, or adjusted to topographic features. There is great force in a sound idea. No stronger case need be made for the desirability of a city plan and for the functioning of a metropolitan planning commission. However, the realization of such objectives under existing social, political, and legal mechanisms seems painfully slow to most. The question is: Is the personal freedom of our haphazard, unplanned, competitive system worth more than the uniform comfort and health of life within the orderly, but regimented, beehive produced from a master blueprint? Can we retain the one, and have the other, all within our lifetime?—MALCOLM J. PROUDFOOT

ANNOUNCEMENT

The Army Map Service is now offering an opportunity for limited employment to qualified graduate students in the field of map research. The appointments are under Civil Service and carry an SP-4 rating for a period of one year. Among the objectives toward which research will be directed in 1947 are a critique on Japanese military mapping and a monograph on the history of map authorities.

For further information and for application blanks address the Association of American Geographers Committee for Liaison with Army Map Service, Department of Geography, Northwestern University, Evanston, Ill.

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THE BANGWEULU SWAMPS OF CENTRAL AFRICA*

FRANK DEBENHAM

THERE is something sinister and gloomy about the word "swamps," and no doubt the readers of this article will conjure up, as I did before I went there, a somewhat repellent picture of this particular African variety of swamp. They will probably connect it vaguely with the lonely death of David Livingstone in 1873 and add to that a general atmosphere of fever, hostile natives, crocodiles, and other unpleasantnesses to taste.

For my part I had no excuse for gloomy anticipation, since immediately before going there I had had the advantage of meeting several white men who had found the swamps enchanting and would snap at a chance of fleeing to them away from the grind of official business. Nevertheless, I was quite prepared to discount the praises of these hearty young men in favor of hazard by disease or capsize, not to mention rude encounters with hippo or crocodile, when, on May 4, 1946, I found myself overlooking Lake Bangweulu from a low headland known as Mwamfuli halfway down its western shore.

As guides and protectors I had Messrs. Brelsford and Clay, both District Commissioners of Northern Rhodesia, to whom the idea of a visit to their beloved swamp was pleasurable for any reason, but particularly so now that they, Oxford men, were to initiate a Cambridge professor into its mysteries.

Preparations for the Journey

In spite of enthusiasm one does not plunge lightly into the maze of channels and lagoons that make up the Bangweulu swamps or without due precautions, and Clay had assembled quite a flotilla for the purpose. Headed by a Diesel launch, called the *Maizie* in token of its most frequent load and towing a steel barge, the fleet also consisted of the *Marianne*, a 40-by-4-foot

* Professor Debenham spent 10 months in Africa (1945–1946) investigating water resources in various territories from the Kalahari northward. The official report on the entire journey will be issued as a Colonial Office publication.—Edit. Note.

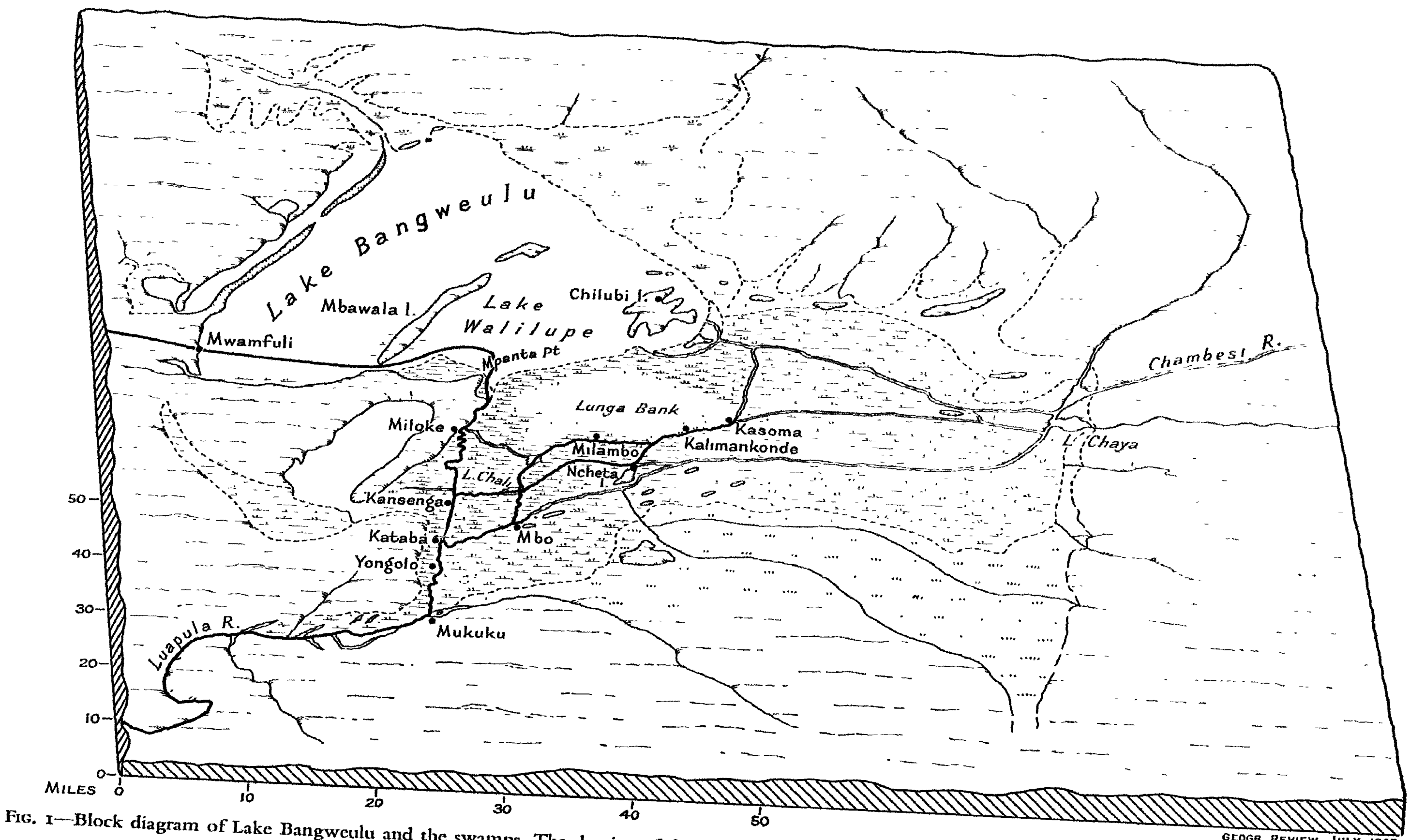
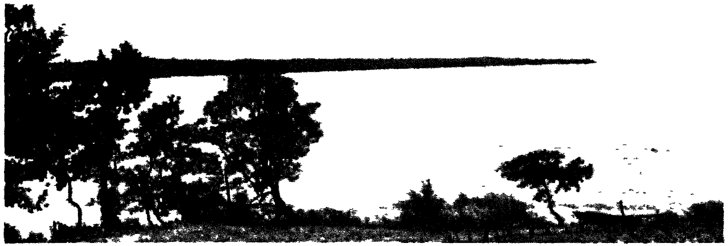


FIG. 1—Block diagram of Lake Bangweulu and the swamps. The density of the swamp symbol is in rough proportion to the density of the vegetational growth.



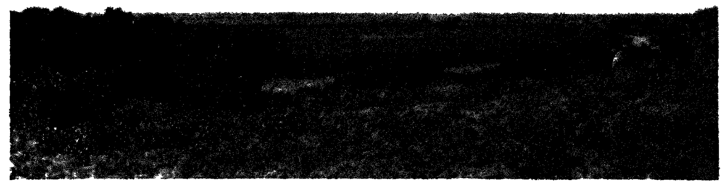


FIG. 2—Overlooking Lake Bangweulu from its western shore.
FIG. 3—A freeboard of a few inches is sufficient.
FIG. 4—A swamp village barely three feet above water level.

FIG. 5—The ferry across the Luapula River at Kapalala.
FIG. 6—The 20-foot bank fringing the west side of the swamp.
FIG. 7—Fishermen's temporary reed huts floating on the papyrus.

steel canoe with 12 paddlers, and six dugout canoes to carry camp equipment and firewood, not to mention the manpower that might be needed to clear channels or wade ashore or do a hundred other jobs that the cheerful African does at a word from those in authority.

Each canoe carried also a "messenger." "Messenger" is a most inadequate word to denote the native backbone of the whole administration, a corps of men who in neat blue uniform and red fez undertake, unarmed, nearly all the duties that in the army are done by the N.C.O.'s. Though military in bearing, the only time the six messengers used military custom was at dawn and dusk when they were marched up by their grizzled veteran, Yeybo, with many a "Righta-turna!" "Stantease!" and "Shon!" to salute in front of the District Commissioners' tent. Broadly speaking, you call upon a messenger for anything from buying a chicken (a "kuku") from the village headman to making a road 20 miles through the forest; from pitching camp to quelling unrest in a discontented tribe.

Needless to say, this was not just a holiday jaunt; there was a problem to be looked into, a hydrological problem affecting the welfare of many thousands of natives, as will appear later.

While we were awaiting the loading of the canoes, a handsomely marked Gaboon viper was killed just outside the resthouse, from whose fangs I forced at least half a cubic centimeter of poison. Obviously one could not wander regardless in the long grass; nor could one paddle on the beach below the headland, since a glance at the clear green water showed not only numerous fish but the occasional wake of a crocodile swimming lazily offshore.

Expert Watermen

Early afternoon saw us embarked on the *Marianne* with our 12 manpower of paddlers and a 22-horsepower outboard motor of imposing appearance and somewhat intricate design. In open water the motor took us along at 4½ knots, but this was too giddy a speed in the twists and turns of the swamp channels for a canoe 40 feet long, nor did the propeller take kindly to the flotsam of leaves and stems, so after two days of rather random service it was unshipped, and we relied entirely on the paddlers.

On our course southeast across the lake we kept the bluff western shore in view for some time. Its steepness and its direction served as a reminder that the lake depression may well be a manifestation of the widespread rifting on both large and small scale that is characteristic of Central Africa. If that is so, then it is certainly on the small scale here, since in few places is the lake more than 30 feet deep.

The eastern shore gradually took shape as a long, dark line of dense

papyrus and phragmites reeds, which was to be our characteristic horizon for the next ten days. This was the long, low island of Mbawala, which stretches its 20 miles of sand and reeds parallel to the western shore and has a fairly dense population at the north end. Some of its inhabitants were out fishing, and we were introduced to the curious illusion, often mentioned by travelers, that the natives were standing on the water. This is because they always stand in their narrow canoes and are quite satisfied with a free-board of two to six inches, so that the canoes themselves are hardly visible until one is within a couple of hundred yards. Not only are the canoes too narrow for sitting, but the natives' ordinary stance is with one foot in front of the other, as if walking, which makes their feat of balance still more remarkable.

The swamp dwellers are notoriously poor walkers, and they make execrable carriers, simply because their normal way of getting about is by propelling their canoes with their arms, their legs being merely supports; and their feet are always tender because they are more or less permanently wet. In spite of rumors to the contrary, I can assert that they do not have webbed feet, in which respect they are far behind the antelope of the swamps in evolution; for they, the lechwe and the situtunga, have enormous long splayed hoofs to enable them to traverse the floating debris.

As we passed through the narrow strait at the south end of the island, there was some uncertainty about our course because floating islands of papyrus had changed the scenery in the few weeks since our pilots had last been there. So we found ourselves twisting and turning through acres of gorgeous mauve and pink lotus flowers, the leaves of which, blown up by wisps of wind, showed blood purple. Over the leaves ran the long-toed lily-trotters (*Jacana*) until, startled, they flew away with their yellow legs hanging down, like giant wasps. The weed was too much for the outboard, so the paddlers, to their obvious joy, took up their duty for the last mile or so. Their method of sliding the upper hand down the long handle of the spear-bladed paddle at the end of the stroke and up again during the return was particularly intriguing. They could not explain why they did so, of course, and probably had a poor opinion of the English *bwana* for asking such a silly question, so I was left guessing, my guess being that the action permits the blood to run down into the arm for a moment instead of being above shoulder height all the time. They keep excellent time at 30 to 40 strokes to the minute, at which rate they will paddle all day, occasionally changing sides or missing a few strokes to take a pinch of snuff passed round from someone's store.

Their harmony singing, usually in a minor key, is remarkable, and no

matte: how tired they were at the end of the day they invariably finished in quick time with a really hearty chantey, which took on the character of a war cry as we grounded on the soft mud of the landing place.

Mpanta Point, some 30 feet high, marks the outlet of the lake and the beginning of the great Luapula River, which ultimately becomes the Congo. It begins in style, half a mile in width; but if there is such a thing as a river with only one bank, here it is, the other bank being a wall of reeds growing in some 10 or 12 feet of water, the nearest dry land 60 miles away across the swamps to the east.

A Bird's-Eye View of the Swamps

At this point we shall do well to take a bird's-eye view of the swamps as a whole and of their problems, so we shall imagine ourselves levitated above Mpanta to some few thousand feet. Looking east, we find we are at about the mid-point of the base of a large green triangle with sides some 100 miles in length.

At the northwest corner is the lake itself, looking quite impressive with its 60 miles of length and 30 of breadth, but obviously so shallow that it only just escapes the fate of being a swamp. Its islands, too, are impressive as to area but disappointing as to height above the water. The chief one is Chilubi, now home of a famous mission, formerly under the churlish chief who gave such tardy assistance to the stricken Livingstone when he asked for canoes to get across the lake.

Beyond Chilubi we can follow the line of the swamps toward the east, since it is marked off from the tree line, the true shore, by a belt of lighter-colored grassland, covered only in flood and the home of game. We note that on this northern side there are very few rivers coming into the depression. At the apex of the delta, for that is what our green triangle is, there is the silvery gleam of a river of character, the Chambesi, and we recognize it, rightly, as the origin of the delta. There are one or two fair-sized rivers running in on the southeast side whose contributions must not be neglected, and at the third corner of the triangle we observe the outlet. The Luapula has filched the name from the Chambesi, though the latter has provided three-quarters of its water.

The bird's-eye view has told us at a glance that the swamp area is the once-large proto-Bangweulu Lake, now filled with the deltaic silt of the Chambesi, which has still not quite reached the surface but is shallow enough to support some three thousand square miles of dense aquatic growth.

Yet although that broad and simple statement is accurate, it leaves out the detail of the swamps which is responsible for the human problem.

The dozen or so small islands that we can see are crammed with huts and gardens, and for every village we see there are many others beneath the water, mere scattered mounds of clay, vestiges of huts now slumped back to their original mud. The inhabitants took to their canoes as the water rose and fled to the mainland to be the unwilling guests of the fierce Awemba tribe, longing the while for their water-girt villages. The northern half of the swamps was occupied by the Ba-Unga, who were more agricultural than the fisher Batwa of the southern half. Their chief home was the Lunga Bank, which from our high point we see as a lighter patch beginning some few miles to the east of Mpanta Point and covering an area of more than thirty thousand acres. This was formerly above water except in the rainy season and was covered with villages, each on its own slightly higher piece of land.

This, then, is the chief human problem. The physiographic problem is how the water got there and how to get it away again. We can see that the Chambesi on entering the swamp splits into a series of channels in the manner of deltaic streams, but in very few places are there any banks to the channels, the sides being marked only by reeds growing in four to ten feet of water. Our delta is akin to a very shallow lake, its waters free to move anywhere, with or without channels, except as they are hampered by the dense reeds. We may therefore expect to find that much of the problem is due to this hindrance by vegetation, with which hint we may descend once more to Mpanta Point and resume our journey.

Surveying in Luxury

As we passed round the point to enter the channel next morning, its funnel shape made it seem far more like the entrance of a large river than the exit, and the similarity to the outlet of the Shire River from Lake Nyasa suggests that there is a common cause. I imagine it to be the fact that the occasional northwest winds raise waves large enough to uproot the marsh growth, which then floats down the channel. In two miles the channel decreases in width from half a mile to 200 yards and then fairly steadily to 40 feet, but the "banks" are mere walls of reed growing in water of some six feet. The illusion of going up a river instead of down is strong until the channel becomes narrow enough to show the bending of the reed stems to a current that in places is running at two knots, eddying and swirling round corners, carrying small floating islands of dense papyrus, for which the generic name is "sudd."

At Mpanta Point I began the map of our cruise, which ultimately covered about 150 miles of waterways. The scale, about 500 yards to the inch, was

chosen so as to be large enough for plotting the width of channel accurately, if unconventionally, but it had its disadvantages, since it not only used up nearly all the paper we carried but when pieced together was about 40 feet long.

The survey can only be described as a hybrid between a time-compass traverse and a plane-table traverse. Never before had I surveyed in such luxury. The four-foot canoe just accommodated a firm camp table, on which were spread paper, protractor, compass, aneroid, stop watch, etc., which I used in turn sitting in a camp chair. A lead line dropped over the side gave me soundings, or, in shallower water, a gesture to the paddler behind me would cause him to grin and thrust his six-foot paddle to arm's length below the water without any check to our speed. A word to our head messenger and we would check or turn or stop to investigate some doubtful point. Soon the whole crew were imbued with a fervor of curiosity and were volunteering information as to any change in the current, or a shallow place, or the name of an inlet or distant village. Their sense of humor was keen, and great was the laughter at any little joke, as when I solemnly called for a paddle sounding when crossing a lagoon that was obviously more than 20 feet deep, or when the one bearded paddler stumbled as he stepped ashore and the D.C. said he had trodden on his beard and held up a wisp of roots to show what had been pulled out.

Occasionally a bend in the stream took us close to the 20-foot bank that edges the west side of the swamp, and at one village, Miloke, this meager height enabled us to see some of the meanders we were about to thread, which indeed amazed the D.C.'s when they saw them shaping on the map. The dugout canoes saved much time by pushing through the reeds to cut off the larger bends, but I asked to be taken by the widest and most nearly permanent channel for mapping purposes, much to the surprise of the paddlers.

By early afternoon the channel had dwindled to 20 feet in width, with higher and denser papyrus than ever at the sides, and after passing two small artificial channels on the left and right we soon came to the dead end of the visible channel of the great Luapula. Here, where Brelsford had cleared the channel only three years before, the water was now plunging beneath and through the accumulation of semisolid sudd.

The Brelsford Cut

Turning back, we took the Palm Tree Cut, which should be known as the Brelsford Cut, since it was he who made it in 1944. Because it is at right

angles to the main movement of the water, it does not catch the sudd and is kept clear with but little maintenance for the mile or so to the village of Kansenga, known far and wide for its cluster of four or five palm trees. A pleasing account of the cutting of this channel has appeared from Brelsford's own pen.[1] It was a striking commentary on the waywardness of the currents in the swamp channels that Brelsford was most anxious to see whether the current in his cut was flowing west or east, since it had done both during his cutting operations!

While our tents were being pitched in the village, we continued down the cut and found it in good order after the two years. We heard how it had been cut, much of it in the unhealthful rainy season, with hoes and shovels by the local natives standing in three feet of water, with not a few hazards from crocodiles or current. One man in diving for a hoe dropped in six feet of water was swept under the sudd and never seen again.

The hydrological lesson of the day was plain enough: there is a definite gradient southward from the open lake, and the river follows it as best it can, either along the channel or, where that has been blocked, under the sudd. The sudd backs up the flow to some extent; hence the fierce currents Brelsford suffered from when making his channels. It is significant that only one of the early maps has ever shown a through channel for the Luapula in this part, and that was made by a man who had never visited the actual spot. It seems therefore that if the river ever does force a channel for a while it is soon blocked again by fresh sudd.

At Kansenga we had to part from our tender, the *Maizie,* which we should meet lower down the river, since we were bound for channels too narrow and shallow for it.

East to Lake Chali

On the morrow we headed due east up a narrow channel which was originally known as the Peta Peta Channel but which was widened for the 1914–1918 war by the District Commissioner of that day, E. H. B. Goodall, and hence is now known as the Goodall Cut.

Since we were making the first passage of the year along the cut and had a rainy season's growth to cope with, we were preceded by about 20 villagers in their narrow canoes to clear obstructions. We caught up with them at the

[1] W. V. Brelsford: Making an Outlet from Lake Bangweulu in Northern Rhodesia, *Geogr. Journ.*, Vol. 106, 1945, pp. 50–58. See also Mr. Brelsford's report "The Bangweulu Channel," *Rhodes-Livingstone Inst. Journ.*, No. 1, 1944, pp. 50–54 (noted in the *Geogr. Rev.*, Vol. 36, 1946, p. 157) and his "South of Bangweulu: A Canoe Journey through African Swamps," *Geogr. Mag.*, Vol. 14, 1941–1942, pp. 48–54.

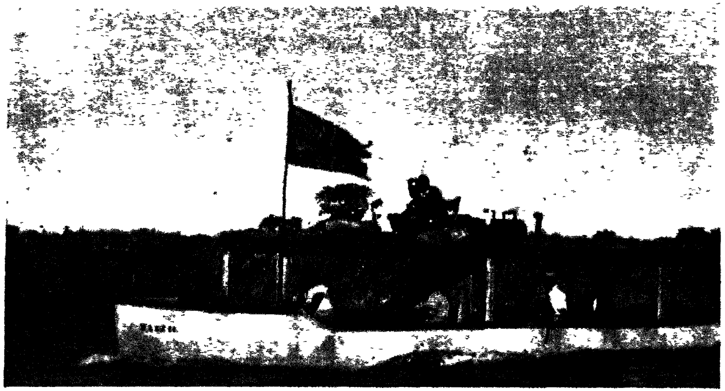


Fig. 8

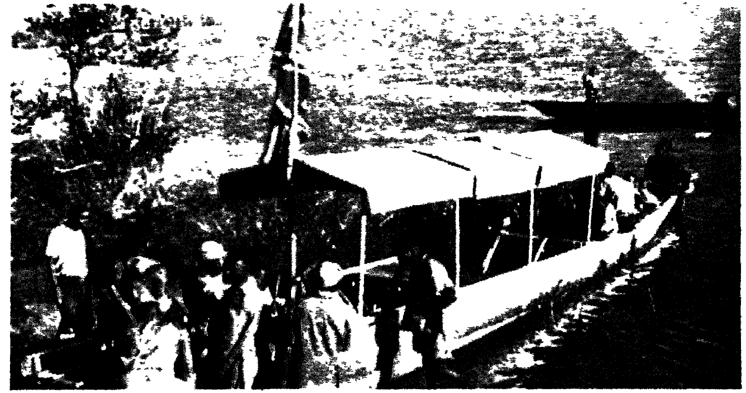


Fig. 10

Fig. 9

Fig. 11

Fig. 8—Our tender, the Diesel launch *Maizie*.
Fig. 9—Kansenga village and its cluster of palm trees.

Fig. 10—The *Marianne*, a 40-by-4-foot steel canoe.
Fig. 11—The chief and his village on Ncheta Island.

FIG. 12

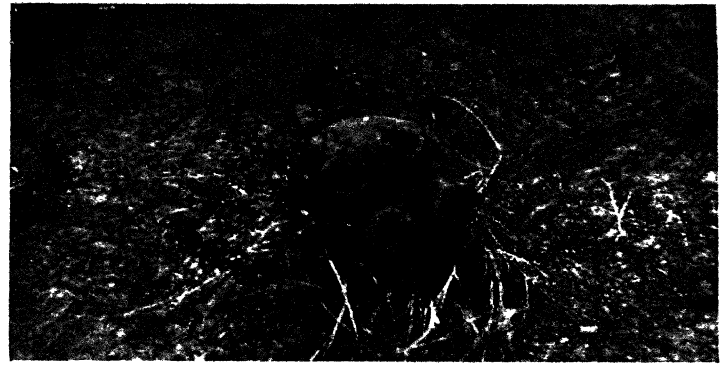


FIG. 14

FIG. 13

FIG. 15

FIG. 12—The village school full blast under a tree (p. 364).
FIG. 13—The village drum.

FIG. 14—A small sacred pot of curious shape (p. 363).
FIG. 15—The old chief, Kasoma.

first barrier, where they helped to push us through, and then, mounting their canoes, they shot past us to deal with the next difficulty. Nothing could disturb the perfect equilibrium of these aquatic acrobats, even when they collided with the steel side of our heavy canoe, and they vanished round the next curve with shouts and laughter. The current was strong, as much as two knots, and running due east.

Nearing Lake Chali we dismissed our temporary helpers and halted while our D.C.'s climbed each into one of our auxiliary dugout canoes to go duckshooting for the pot—with success. They were immediately lost to sight, for even standing up one could not look over the reeds, and the channels were vague and quadrivious. However, their paddlers seemed to have the necessary instinctive sense of direction, and in due course we all came out on the broad bosom of Lake Chali, which is a sort of Clapham Junction for the swamps, where all routes meet. It is really a large lagoon with no banks, and all the channels into it difficult to find.

We were seeking the Tushingo Channel, bringing water from the east, and had some trouble in finding it. Our auxiliaries went straight east through the reeds, preferring, in fact, to avoid the channel and its strong current.

Although it was too early in the season for much fishing, it was on the edges of Lake Chali that we first saw evidence of this old and flourishing native industry. The best variety of fish, a species of *Tilapia,* of excellent flavor, is caught chiefly with nets and traps in the lagoons. As the lagoons have no banks, the fishermen build temporary reed huts on the thicker patches of papyrus, the floors of which are literally awash. For weeks on end they live in these "humpies," drying their catch in the sun and making up long, cigar-shaped bundles, which some of the party take to market. The principal market is the Copper Belt, 150 miles away, and the bundles are taken on the first stage by canoe and for the rest of the way are carried on the head or wheeled on a bicycle.

The improvement of conditions for the transport of fish is one of the objects of the channel cutting mentioned above, so that in due course it may even be delivered fresh to the market.

Ncheta Island

By midafternoon of our second day we were approaching Ncheta Island and its chief village, which rejoices in the tongue-twisting name of Bwalya Mponda, and here we first experienced the characteristic welcome of the swamp inhabitants. The whole village, warned only by the singing of the paddlers, was at the waterside as we approached, the women kneeling

in the mud and dust. As we stepped ashore, the whole crowd bent their heads, clapping their hands gently in unison and saying "Mutende, bwana (Peace be unto you, master)," while the women uttered a rapid "Uh-lu-lu-lu" in a high key. This was just their natural politeness, with no flavor of servility about it; and when the greeting was over, smiles of interest and pleasure showed on all their faces.

As our tents were being pitched, there were palavers between the chief and the D.C., a march past of the school children behind their teacher, and endless curiosity on the part of peeping pickaninnies.

With the swamps only a few feet away, the night was alive with mosquitoes, which we countered as far as possible by having meals under a mosquito net and by taking steady doses of quinine. It was noticeable that the malaria culprit, the *Anopheles* mosquito, did not depart at dawn but stayed to catch the white man writing his notes with his morning tea at 5:30.

Embarked again by 7 a. m., we set our prows due north along a comparatively narrow channel and immediately came upon one of the little puzzles the swamp has to offer. We were paddling against a rather strong current, yet without leaving the channel we would suddenly find an equally strong current with us. We met several such reversals during the day, and it was Yeybo's particular care that each of them should go down on my map. The explanation is that water discharges into the bankless channel and runs along until it reaches some outlet on the other side. The net flow, however, was from the east and north.

The Drowned Lunga Bank

We were now approaching the sunken edge of the once densely populated Lunga Bank and saw plenty of evidence of the drowned villages and gardens. Early in the afternoon we reached one of the remaining villages, Kalimankonde (Place of Weeping), which had been trying to save its last foot or two of dry land by extensive digging and damming, so that we had to change to native canoes, the last few hundred yards being too shallow for our forty-footer.

Some hundreds of people were living here so close together that our tents had to be set up among their mud huts. My own almost desecrated a small shrine of animal skulls and other trophies, about which, however, the chief did not seem to worry. Nor did he show much interest when I took a photograph of a small sacred pot of curious shape that occupied a space big enough to accommodate an extra hut. This four-mouthed pot was reputed to move itself from one part of the village to another at dead of night.

A small village school was in full blast under a tree, and one could vouch for at least a strict discipline, since not a single "toto" looked round at the strangers, though there may have been a roving eye or two.

The remainder of the daylight was used to bring the traverse plotting up to date, and night was enlivened by attending a village dance, in which the drums played by far the most skilled part. In the light of a half-moon it could be seen what hard work it was for the drummers, who were imbued with the excitement they were imparting to others, and how much our swarm of canoemen were enjoying themselves.

The next morning we paddled up a narrow but swift channel to Kasoma's village, now the largest of all those that once graced the Lunga Bank. After the customary hand clappings and ululations by the women we were welcomed with great dignity by the old chief, Kasoma himself, who dates back to the days of slavery, of Joseph Thomson's journey in 1890, and possibly of Giraud's in 1883, though neither of them penetrated the swamps proper. He appeared to be a tired but kindly old gentleman and returned my present of cigarettes with an enormous hand of bananas. This was the remotest village that we visited, and the women and children fled with cries from my secretary, since the only other white woman they had ever seen was a missionary doctor who had inoculated them. The village was crowded and was barely three feet above the present water level, and this was a foot lower than a month or so earlier. Many cassava mounds were half flooded, and as this is almost their only vegetable food, their situation is somewhat precarious.

Had we gone farther north up the narrow channel, we should have reached the northernmost channel of the deltaic stream that flows into the lake, which must run at a higher level than the branches to the south.

At this stage of the journey it became evident that whatever else might be the cause of the flooding of the Lunga Bank it was certainly not the outlet from the swamps at their southwest corner and that I was visiting the wrong end of the swamps altogether. However, when one has started on a route in the maze of channels, the original program has to be maintained. We turned back and made for our tender, waiting for us at Kataba on the Luapula.

Return to Kataba

We took the Churchill Channel, recently cut by Mr. Benson, successor to Mr. Brelsford as District Commissioner. It runs roughly along the southern end of the Lunga Bank, past the village of Milambo, which is still well above water. This channel occasionally had visible banks, and when deepened

will be a useful route for small barges. It is too small, however, to have much effect in discharging the present flood. After passing the night at a village crowded onto little more than 1½ acres, having waded through mud to reach it, we spent a long day getting to solid land at Mbo. The route led through two lagoons, Bukali and Chisebe, both fishing grounds, and then to Lake Chali again. There was some difficulty in finding the outlet from the lake, since it might have been any one of a dozen vague embayments in the reeds; even the paddlers were of divided opinion. We were here back in the country of the Batwa, the true fishing tribe. They still have not lost their dread of strangers, who formerly were likely to be enemies; consequently, although we occasionally saw a slim canoe sliding into the reeds, we had no communication with them, and our six attendant canoes had to act as scouts, all putting up a race when the right point was found.

It is difficult to paint an adequate picture of those day-long passages down channels and across lagoons, or to portray the charm that easily outweighed the discomforts and the insect pests. The reeds themselves were mainly of three kinds. The tufted papyrus, surprisingly strong and useful for nearly everything the native requires from string for his nets to thatch for his roofs, grows in favored spots to 12 feet above the water and is exceeded in height only by the phragmites, whose stem is rather more woody. The third typical plant is a reed that appears to have only a single stalk about the thickness of a pencil and grows quite happily in ten feet of water but rarely rises to more than three or four feet above it.

On these reeds we found large caterpillars of a dull-green, hairy type, in such profusion in places that every stem had its caterpillar. In other places we found numbers of tiny green frogs each perched on a stem.

Every lagoon or slack water was edged with the red and purple lotus. An even daintier flower was a large convolvulus that covered the phragmites with its blossom-loaded vines. The stronger currents seemed to be the habitat of a white, a pink, and a yellow flower, all of the water-lily tribe. Birds were not as common as one would suppose, but certainly there were few places where they could perch.

The songs of the canoemen, the sallies as the other canoes passed, and the conversation of our guides formed a pleasant background to the sights and the thrills of these strange waters. The smaller canoes could ignore the open channel wherever the reeds were thin, and we would lose them for hours till we would see six bobbing heads beyond a horizon of reeds.

The channels carry faster, more silty water. They tend to build a low bund or levee along their sides, and the shallower water bears higher reeds,

which look almost impenetrable. As we neared the main channel of the Chambesi, we saw one canoe after another charge at the hedgelike mass at the side and wriggle out of sight. When we in turn followed, we found ourselves in a wide expanse of thinly reeded water about nine feet deep, having passed over a submerged levee four feet deep, edging the main channel, 20 feet deep. These subaqueous levees are clearly of importance in the regime of the swamps, since they tend to canalize the channels and make them permanent.

At the small island of Mbo we found the village carefully swept and clean but deserted, the inhabitants having gone some miles away to harvest their crops. They had left all their mosquitoes behind, however, and also some noisome red driver ants.

The next day we quickly ran down the Chambesi channel with a two-knot current to its confluence with the Luapula at Kataba, where we rejoined the *Maizie*.

Down the Luapula to Kapulala

I transferred my plotting table to the roof of the launch, from which I was able to see over any reeds less than ten feet in height, and thus enlarged my horizon in a very useful way. For the next two days I grilled in the sun, but my plane-table traverse was improved. The crew were much interested in seeing me wearing three pairs of glasses—the half-moons for the drawing covered by the full-round for distance and over them the dark glasses for glare.

We spent the night at Yongolo under a mighty fig tree, round which swarmed millions of dragonflies, feasting, we were assured, on the mosquitoes. If so, they certainly did not leave the platters clean.

The combined rivers wind south from here in a channel curiously narrow but deep, with extensive lagoons and even anabranches on either side. Beyond the lagoons we began to see the extraordinary termite mounds that have attracted the attention of all travelers in these parts, from Livingstone on. They are not only very wide and very high, as much as 30 feet, but they are rendered handsome and conspicuous by being the only land on which trees can grow, so that each hill is a miniature grove. Where there are enough of them, they will even bear a village, or, if left to themselves, they form a tiny patch of thick jungle known locally as a "msitu," a prime haunt of game during the heat of the day and of insects at night.

At Mukuku we reached a real riverbank at last, the boundary stone of the Belgian Congo, and the end of the Bangweulu swamps proper. The river

becomes wide, as much as 200 yards, and is never more than a few hundred yards from its true banks. We must therefore omit the pleasant cruising of the next two days down to the ferry at Kapalala and return to the problem of the main Bangweulu swamp.

The Problem of the Swamp

Its general shape, that of a large triangle with its apex at the east, is explained if we recognize that it forms the delta of the Chambesi, which has all but filled up the ancient lake of Bangweulu.

This does not account for the periodic flooding, which at first seemed to be in unison with the rise and fall of other African lakes and therefore was taken to be a cyclical event. We could hardly expect data to be available at so remote a place, but from native accounts it is possible to distinguish three such rises and falls since 1890. They are unequally spaced, however, the "lows" being about 1890, 1920, and 1935, the "highs" in 1910, 1930, and 1944. Nor is the outlet involved as in the case of the Great Lakes, where a blockage will raise lake level. The swamp water, as we have seen, is not level but has a pronounced gradient from northeast to southwest of about three inches to a mile.

From the data on direction of flow of the water we deduce the phenomenon of a vast triangular sheet of water the three corners of which are at different levels, highest in the east, intermediate in the northwest, and lowest in the southwest. So unnatural a state of affairs, a tilted lake surface, can be due only to the obstruction of the millions of stems of swamp vegetation, and unfortunately we have no real data on the flow of water through such vegetation in the mass. On the whole, we must ignore the relief of the submerged delta itself and pay attention to the slope of the water surface. And a strange surface it must be. For instance, in lagoons such as Lake Chali, free from swamp growth, the surface must be level, yet through the swamps surrounding it the surface is tilted as the water slowly seeps through the myriad stems to reach the lagoon.

This complex state of the water surface does not of itself explain the periodic flooding, for it is a consequence of the flooding, not a cause. Nor can we hope to relieve the flooding of the Lunga Bank merely by digging channels to take the water off, for the area is much too vast.

We must therefore look for the ultimate cause of that high water level in the north and east of the triangle, for which we must go to the apex, whence the water is, so to speak, distributed over the delta.

Obviously there is some condition, simulating a periodicity, that deflects

the main flow of the Chambesi, sometimes toward the northern, sometimes toward the southern, flank of the delta. Ignoring the suggestion of tectonic movements, which have been unnecessarily called in, I would suggest that there are only two possible "deflectors," namely silting and growth of vegetation, and I should prefer not to separate them, since they belong together.

When a stream entering a delta breaks up into a series of channels, as the Chambesi does, a very small obstruction in one will tend to cause more silt to be dropped, and this may go on in a cumulative manner until an altogether new channel is formed. Conversely, a more or less accidental freedom from obstruction in one channel may induce more water to flow down it and cause it to become dominant, claiming the greatest share of the water until it in turn becomes choked and loses its dominance. The changes of flow may easily appear to have a cyclical or periodic character.

It is to some such process as this that I should attribute the alternate flooding and drying out of the northern section of the swamps.

To find the root cause of the trouble will be comparatively simple, to remove it not so easy. One cannot experiment with impunity with three thousand square miles of swamp, the home of some thousands of people and of at least two industries, cassava growing and fishing. Overdraining may seriously affect the fishing industry; underdraining affects the croplands.

Clearly, the first thing to be done is to make a hydrological survey, with special attention to the eastern end and the southernmost channel of the delta, which could become an important waterway for the produce of the Chambesi basin upstream.

Devising works to control the distribution of water in a delta has broken the stout heart of many an engineer, but ultimately the rewards justify the outlay.

GLACIER RECESSION IN MUIR INLET, GLACIER BAY, ALASKA*

WILLIAM O. FIELD, JR.

[With separate map, Pl. I, facing p. 398]

MOST of the earth's glaciers have been shrinking in recent decades, but in no locality have observations revealed more spectacular recession than in the Muir Inlet arm of Glacier Bay in Southeastern Alaska. Here there is an unusual chronological record, three-dimensional in scope, resulting from direct measurements and a comparison of maps and photographs. During the last two-thirds of a century the area covered by glaciers draining to the inlet has been reduced about 35 per cent, or some 175 square miles; the area of sea water has increased by about 47 square miles, somewhat more than twice the area of Manhattan Island in New York City. At the farthest point of recession the vanished ice had a thickness of more than 2600 feet, which is twice the height of the Empire State Building. The Muir Glacier of the 1890's with its many tributary ice streams has now been dismembered by recession into twelve separate glaciers, of which three actively discharge icebergs into Muir Inlet, five are valley glaciers terminating on land, and four are remnant glaciers cut off from their former sources of supply. Because of the rapidity of this recession and the comparatively long record of fairly detailed observations, this area provides a unique opportunity for studying the various phenomena associated with shrinking glaciers and the emergence from under the ice of new land and marine features.[1] Here is offered an example on a small scale of conditions which have prevailed many times in geologic history during the waning of the continental ice sheets and which in future may affect millions of square miles of the earth's surface now buried beneath glacial ice.

The map, Plate I, accompanying this article shows the general topographic features of the area surrounding Muir Inlet as recorded during the

* The writer is deeply indebted to Colonel Lawrence Martin for his help and advice in the preparation of this article and map. Grateful acknowledgment is also made to Dr. François E. Matthes, chairman of the Research Committee on Glaciers of the American Geophysical Union, Professor William S. Cooper, and members of the U. S. Geological Survey for their cooperation and to the late Professor Harry Fielding Reid for his encouragement and guidance. To Mr. Stanley F. Smith special thanks are due for his work in preparing the map for publication.

[1] The broad aspects of what is known at present of the post-Pleistocene geomorphic history of this area have been admirably summarized by Professor William S. Cooper in "The Problem of Glacier Bay, Alaska: A Study of Glacier Variations," *Geogr. Rev.*, Vol. 27, 1937, pp. 37–62.

decade ending with 1946. It is designed to serve as a basis of comparison with earlier maps and a reference for the future. Present indications are that ice recession will continue and that within a few decades—our own lifetime, in fact—a large area of land surface now buried under hundreds or thousands of feet of ice will be uncovered. On the other hand, the present trend may be reversed, and a general advance of the glaciers may set in. It therefore seems highly desirable that close observation should be kept on this area and that changes here and in the surrounding region should be carefully and systematically recorded. All of Muir Inlet is now included in the Glacier Bay National Monument, established in 1925 and administered by the National Park Service. There has been no development of park facilities, but plans are under consideration to encourage some tourist travel. One may express the hope that such development will also include provision for scientific inquiry.

In connection with the publication of this new map of Muir Inlet it seems worth while to review briefly the earlier mapping in this area and to call attention to such photographic records as can be directly correlated with these surveys.

Observations in Muir Inlet, 1880–1946

Muir Glacier was first visited by John Muir in 1880,[2] but it was not until G. Frederick Wright's visit in 1886 that the position of the terminus was fixed and a rough sketch map was made of parts of the upper glacier.[3] In 1890 Harry Fielding Reid mapped the position of the terminus and, with Muir's help, determined where it had been at the time of Muir's first visit.[4] In 1892 Reid again surveyed the inlet and the ice front and extended his topographic survey of the upper glacier.[5] In 1895 the Canadian Boundary Survey mapped the entire drainage basin of Muir Glacier and established its relationship to the glaciers issuing from the same névé areas and mountain ridges northward into the Tsirku and Takhin Valleys and eastward into Lynn Canal.[6] In 1899 John Muir, Grove Karl Gilbert, and Henry Gannett

[2] John Muir: Travels in Alaska. Boston and New York, 1915, pp. 262–269.

[3] G. F. Wright: The Muir Glacier, *Amer. Journ. of Sci.*, Ser. 3, Vol. 33, 1887, pp. 1–18; *idem:* The Ice Age in North America and Its Bearings upon the Antiquity of Man, New York, 1889.

[4] H. F. Reid: Report of an Expedition to Muir Glacier, Alaska, with Determinations of Latitude and the Magnetic Elements at Camp Muir, Glacier Bay, *U. S. Coast and Geodetic Survey Rept. for the Fiscal Year Ending June 30, 1891*, Washington, 1892, Part 2; pp. 487–501. *idem:* Studies of Muir Glacier, Alaska, *Natl. Geogr. Mag.*, Vol. 4, 1892, pp. 19–84. See also H. P. Cushing: Notes on the Muir Glacier Region, Alaska, and Its Geology, *Amer. Geologist*, Vol. 8, 1891, pp. 207–230.

[5] H. F. Reid: Glacier Bay and Its Glaciers, *U. S. Geol. Survey, 16th Ann. Rept., 1894–95*, Part 1, 1896, pp. 415–461.

[6] Boundary Atlas of Alaska, Sheets 14, 15, 17, 18 , 1 : 160,000 (Survey of 1895).

of the Harriman Alaska Expedition determined the subsequent changes in the position of the Muir terminus.[7]

Thus from 1880 to 1899 the position of the ice front was determined at least five times, and enough data were accumulated to record its behavior in considerable detail. In addition, the whole upper area of the glacier was

FIG. 1—View east up Adams Inlet from near its entrance, Aug. 20, 1941. In 1892 this whole valley was occupied by a glacier to an elevation of 1400 ft. As a result of its rapid recession the inlet was extended seven miles between 1929 and 1941. See Figs. 9, 10, and 11. (Photo by Field. No. 41-210.)

mapped topographically. During these 19 years the net recession of the terminus measured about 9000 feet along the center of the inlet. However, between 1890 and 1892 an advance occurred of a maximum of about 3000 feet, and the position of a part of the center of the ice front in 1899 was farther forward than in 1890.

After the summer of 1899 a rapid recession occurred, believed to have been accelerated by the great earthquake in September of that year. So much ice was discharged into the inlet that points of observation could not be reached until 1903, when C. L. Andrews and W. H. Case of Skagway worked their way up the shore under Mt. Wright and succeeded in mapping the position of the terminus.[8] The observations and mapping of Fred E. and Charles W. Wright for the United States Geological Survey followed

[7] G. K. Gilbert: Glaciers and Glaciation [of Alaska] (Harriman Alaska Expedition, Vol. 3), New York, 1904, pp. 20–25.

[8] C. L. Andrews: Muir Glacier, *Natl. Geogr. Mag.*, Vol. 14, 1903, pp. 441–444. See also the same: The Retreat of Muir Glacier, *The Mountaineer*, Vol. 24, No. 1, 1931, pp. 11–17.

FIG. 2—Excursion steamer at Muir Glacier in the 1890's. Muir's cabin on the moraine near Cabin Pt.; Morse Glacier at left and Knob G at right. (Photo No. 272 by Winter and Pond, Juneau.)

FIG. 3—Group at John Muir's cabin near terminus of Muir Glacier, Aug. 1890. Left to right, John Muir, H. P. Cushing, R. L. Casement (top of chimney), C. A. Adams, H. McBride, H. F. Reid. (Photo by J. F. Morse, No. 222. Collection of Committee on Glaciers, A. G. U.)

FIG. 4—View up Muir Inlet to Muir Glacier from near site of John Muir's cabin, Aug. 22, 1941. Knob G at left, Black Mt. at right center. (Photo by Field, No. 41-7.)

FIG. 5—Remains of chimney of Muir's cabin overgrown by alders, Aug. 22, 1941. Left to right, R. A. Reischl and Maynard Miller. (Photo by Field, No. 41-10.)

in 1906,[9] and of the International Boundary Commission in 1907.[10] The latter's map of the upper part of the glacier provides a basis of comparison with the maps made in the 1890's for determining the general lowering of the ice surface, the emergence of nunataks, and the resulting changes in local ice currents. In 1911 Ralph S. Tarr and Lawrence Martin, on a National Geographic Society expedition, determined the position of the terminus in relation to earlier surveys.[11] Martin returned in 1913 and with Eugene Romer and F. T. Thwaites mapped the inlet once again.[12] Andrews also revisited the glacier in that year and took a series of photographs (Andrews, 1931).

From 1899 to 1913 the Muir ice front had receded about eight miles. Adams Glacier had developed its own tidal terminus in Adams Inlet, and Casement and Plateau Glaciers had become all but isolated from the main Muir ice stream.

The record since 1913 is unusually detailed because it is possible to correlate very closely the photographs and surveys made in various years (Pl. I, Inset A). The inlet was visited by William S. Cooper in 1916, 1921, and 1929,[13] by J. B. Mertie, Jr., of the United States Geological Survey in 1919,[14] and by Benjamin S. Wood and the writer in 1926.[15] In 1929 the United States Navy took what are believed to be the first vertical and oblique aerial photographs of the inlet and the glaciers. Reid and C. W. Wright returned in 1931 (MS) after 39 and 25 years respectively and made a

[9] F. E. and C. W. Wright: The Glacier Bay National Monument in Southeastern Alaska: Its Glaciers and Geology (unpublished manuscript based on studies in 1906 and 1931 in the files of the U. S. Geological Survey). See also H. F. Reid: The Variations of Glaciers, XII, *Journ. of Geol.*, Vol. 16, 1908, pp. 46–55.

[10] International Boundary between United States and Canada from Cape Muzon to Mount St. Elias, Sheets 9 and 10. 1 : 250,000, International Boundary Commission, 1923. See also Fremont Morse: The Recession of the Glaciers of Glacier Bay, Alaska, *Natl. Geogr. Mag.*, Vol. 19, 1908, pp. 76–78.

[11] H. F. Reid: Variations of Glaciers, XVII, *Journ. of Geol.*, Vol. 21, 1913, pp. 422–426, containing information contributed by Lawrence Martin; Lawrence Martin: Juneau-Yakutat Section [of Excursion C 8: Yukon and Malaspina], *Internatl. Geol. Congr., 12th Sess., Canada, 1913, Guide Book No. 10 (Excursions C 8 and C 9)*, Ottawa, 1913, pp. 121–162.

[12] R. S. Tarr: College Physiography, published under the editorial direction of Lawrence Martin, New York, 1914, Fig. 126; Eugenjusz Romer: A Few Contributions to the Physiography of Glacier Bay Alaska, *Przegląd Geograficzny*, Vol. 9, 1929, pp. 253–279. See also H. F. Reid: Variations of Glaciers, XIX, *Journ. of Geol.*, Vol. 23, 1915, pp. 548–553, containing information contributed by Lawrence Martin.

[13] W. S. Cooper: The Recent Ecological History of Glacier Bay, Alaska, *Ecology*, Vol. 4, 1923, pp. 93–128, 223–246, and 355–365; *idem:* A Third Expedition to Glacier Bay, Alaska, *ibid,* Vol. 12, 1931, pp. 61–95.

[14] Unpublished photographs in the files of the U. S. Geological Survey.

[15] W. O. Field: The Fairweather Range: Mountaineering and Glacier Studies, *Appalachia*, Vol. 16, 1924–1926, pp. 460–472.

photographic and plane-table survey. Cooper and the writer went again in 1935, and later in that year the latter took a series of aerial photographs.[16] They were followed the next year by R. H. Sargent and John C. Reed of the Geological Survey, who fixed the positions of the ice fronts.[17] Helpful photographs were also taken by Bradford Washburn in 1937, Earl Trager of the National Park Service in 1939, and Victor H. Cahalane of the Fish and Wildlife Service in 1940. In 1939 and 1940 the United States Coast and Geodetic Survey mapped the shore line of Muir Inlet and the entrance to Adams Inlet[18] and determined the positions of the ice fronts of Muir Glacier and Plateau Glacier and of the tongues descending close to the inlet. The writer's fourth visit to Muir Inlet was in 1941 and resulted in the map and observations forming the substance of this report. In the same year photographs of the ice front were taken by Reed, and in 1942 another Geological Survey party spent several weeks in a study of molybdenite deposits near Muir Glacier, during which the upper part of the inlet was photographed and mapped.[19] Alfred C. Kuehl of the National Park Service photographed the Muir terminus in both 1945 and 1946. Further observations and ground and aerial photographs were also made in 1946 by Douglas Brown, Maynard Miller, and William Latady.[20]

Survey of 1941

By 1935 it had become clear that a new topographic map of Muir Inlet was needed: only the shore line of the inlet and the positions of the glacier termini had been mapped since the International Boundary Commission's survey in 1907. So many new topographic features had appeared as the ice had receded and shrunk in volume that efforts to determine the new positions of the termini and compute the elevation of the ice surface were seriously handicapped by the lack of near-by known features. In 1941 a survey was undertaken by an American Geographical Society party, which spent 12 days in Muir Inlet in the course of its glacier studies in Southeastern Alaska. In 1939 and 1940 the United States Coast and Geodetic Survey had determined the shore line and bathymetry of Muir Inlet and the entrance

[16] W. S. Cooper: A Fourth Expedition to Glacier Bay, Alaska, *Ecology*, Vol. 20, 1939, pp. 130–155. See also his "The Problem of Glacier Bay" (*op. cit.*).

[17] Unpublished maps and photographs in the files of the U. S. Geological Survey.

[18] Southeast Alaska: Glacier Bay, 1 : 160,000 *U. S. Coast and Geodetic Survey Chart No. 8306*, September, 1942.

[19] W. S. Twenhofel: Molybdenite Deposits of the Nunatak Area, Muir Inlet, Glacier Bay, *U. S. Geol. Survey Bull. 947-B*, 1946, pp. 9–18.

[20] Personal communications and unpublished report to the Committee on Glaciers, Amer. Geophysical Union.

to Adams Inlet, and most of its shore markers and stations were still visible and readily identifiable from copies of the preliminary compilation (later shown on Chart 8306, 1942). The 1941 survey used these known positions as its base and established new stations from which the land features and glaciers surrounding Muir Inlet could be mapped. Nine survey stations were established, of which seven were occupied with a theodolite and two with a surveying compass. Photographs, most of them covering the full panorama, were taken from each of these stations, and, in addition, four other points were occupied as photographic stations. The map uses the base established by the International Boundary Commission in 1907 and the United States Coast and Geodetic Survey in 1939 and 1940. The aerial photographs taken by the writer in 1935 and other photographs were used for sketching topographic details, especially for the areas imperfectly seen from the ground stations. Because time did not permit the establishment of any survey stations in Adams Inlet, ground control was inadequate, and the topography as shown in that area must be considered only approximate.

The locations of the stations occupied between August 15 and August 21, 1941, are given below. All but Station 8, which was on the ice (shown in blue on Pl. I), were marked with cairns and should be relatively easy to locate. Survey stations are designated by numbers and photographic stations by letters.

Muir Station 2. Highest knoll at west base of Nunatak Knob north of Anchorage Cove. Elevation 325 feet.

Muir Station 3. Highest point of rounded knoll between Anchorage Cove and Goose Cove. 377 feet.

Muir Station 4. Summit of prominent knoll on southern part of White Thunder Ridge, directly above west end of Muir Glacier terminus in 1941. 663 feet.

Muir Station 5. Summit of knoll north of Stump Cove and west of Westdahl Point. 405 feet.

Muir Station 6. Crest of morainic ridge between Muir Inlet and remnant ice northeast of Nunatak Knob. 301 feet.

Muir Station 7. Summit of prominent rock knoll on west end of Curtis Hills, between distributary tongue of Burroughs Glacier and Wisconsin Inlet. 1056 feet.

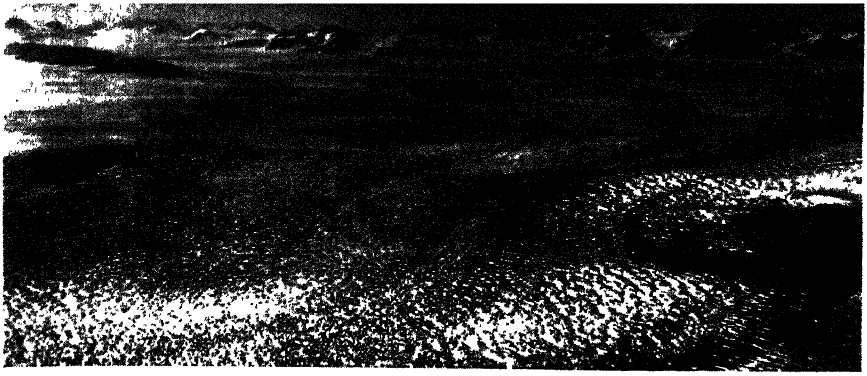
Muir Station 8. On Muir Glacier at eastern entrance to Glacier Pass. About 1369 feet.

Muir Station 9. On ridge north of west end of Glacier Pass overlooking Plateau and Burroughs Glaciers. About 2724 feet.

Muir Station 10. Highest point on foreland between Wisconsin Inlet, Hunter Cove, and Plateau Glacier. 391 feet.

Muir Station A. Summit of Nunatak Knob. 1178 feet.

Muir Station B. Summit of highest knoll on east end of Klotz Hills. A subsidiary station, BB, is on lower knoll to southeast. 748 feet.



3 5 7 8 9

1 2 3 4 5 7 8 9 10

4 5 6 7 8 10

FIGS. 6–8—Muir Glacier 1892–1931. 1, Morse Glacier; 2, Knob G; 3, Minnesota Ridge; 4, Curtis Hills; 5, Mt. Brock; 6, Nunatak Knob; 7, Van Horn and McConnell Ridges; 8, Black Mt.; 9, Knob H; 10, Casement Glacier.

Figure 6, View from Station V at 3000 feet on Mt. Wright, Aug. 19, 1892. Note that Van Horn Ridge and Curtis Hills are submerged. (Photo by H. F. Reid, No. 375; Collection of Committee on Glaciers, A. G. U.) Figure 7, View from Station Wright at 4000 feet on Mt. Wright, 1907. (Photo by International Boundary Commission, No. E. M. 77-07.) Figure 8, View from Knob H, 1931. (Photo

Muir Station C. On high point of low moraine area on north side of Adams Inlet northwest of Adams Glacier. Because of subsequent ice recession, this area may now be an island in Adams Inlet. About 125 feet.

Muir Station D. On southwestern slope of Mt. Kimber south of entrance to valley of Girdled Glacier. A subsidiary station, DD, is farther north on this ridge. About 400 feet.

Two additional photographic stations established in 1946 by Douglas Brown are designated Muir Stations E and F. Station E is on the rocky cape at the south end of the McBride Glacier ice cliff at an elevation of about 100 feet. (Fig. 25). Station F is on the highest point, about 1860 feet, of White Thunder Ridge, first climbed and named by Douglas Brown. It overlooks the whole upper end of Muir Glacier and the lower courses of Muir, Riggs, and McBride Glaciers and may therefore be considered at present the finest observation point in Muir Inlet.

New Names

Few names have been given to the topographic features of the Muir Inlet area since it was mapped by Reid in 1892. The lack has proved a handicap to discussion of ice recession and its resulting phenomena. The new names appearing on the accompanying map have been selected after careful consideration of their suitability and the need of the particular feature for a name. They include Alaskan Indian names, names of persons associated with the early investigations of Muir Glacier and of the institutions with which they were connected, names of eminent scientists who have visited the area and of steamers and their captains associated with the early navigation of the inlet, descriptive names, and names applied by early observers that do not appear on more recent maps. The only changes made in the nomenclature appearing on the latest map of the inlet (U. S. Coast and Geodetic Survey Chart 8306, 1942, 4th edition) are as follows: Sealers Island in place of Muir Island, Wisconsin Inlet in place of Cushing Inlet, and the dropping of the name Cushing Plateau. The names Muir and Cushing are retained for the other features to which they were originally applied.

The names were selected by Colonel Lawrence Martin and the writer. Professor William S. Cooper of the University of Minnesota has contributed valuable suggestions and has given his general approval. It is therefore hoped that this nomenclature will be accepted and adopted officially.[21]

Recent Variations of Muir Inlet Glaciers

All the glaciers in Muir Inlet have shrunk in recent decades, but the amount of recession and lowering of the ice surfaces has varied greatly. As an over-all picture of events depends on details of local variations, it seems

[21] List of names with origin and definition on file at the American Geographical Society.

worth while to present an outline of what is known of the behavior of each glacier during the last few decades. These statements are based on a study of all available sources but are primarily the result of observations made by the writer on four separate visits to Muir Inlet: August 31 to September 4, 1926; August 9 to 11, 1935; October 8, 1935; and August 12 to 21, 1941.[22]

The glaciers will be considered in geographical order, beginning at Mt. Wright and proceeding counterclockwise around the head of Muir Inlet to Ice Valley on the west.

Adams Inlet Glacier

In 1941 the remnant glacier in Adams Inlet had been reduced to two sections of nearly stagnant ice on the north side of the inlet. It is proposed to refer to it here as Adams Inlet Glacier and to apply the name Adams Glacier to the northward-flowing ice stream, east of White Glacier, that Reid so named on the map resulting from his survey in 1892.

By 1890 nourishment of Adams Inlet Glacier had virtually ceased, and it had become an almost stagnant ice mass. From his observations in 1890 and 1892 Reid determined that the ice was being lowered by ablation at an average rate of about 20 feet a year. In 1906 its maximum elevation was determined to be about 1200 feet, and in 1931 about 600 feet. The glacier, though shrunken, remained intact until 1935, when it was observed that the ice had caved in along what is now the main channel of Adams Inlet. Endicott Lake, which in 1906 had had a surface elevation of 800 feet and in 1931 of 400 feet, now became a tidal basin connected by a subglacial channel with Adams Inlet. Tidal action and rapid thinning hastened the breakup of the glacier, so that by 1941 the inlet extended through this area to the site of Endicott Lake, and the glacier was reduced to two isolated sections detached from all former tributaries. Its total area was less than six square miles, its surface elevation not more than 300 feet. Just 49 years previously Reid had written: "At its present rate of sinking the ice will have disappeared from this valley in 50 years."[23] Aerial photographs taken in 1946 indicate that melting has been very great since 1941 and that the area covered by ice has been reduced at least 50 per cent.

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[22] W. O. Field, Jr.: Glacier Studies in Alaska, 1941, *Geogr. Rev.*, Vol. 32, 1942, pp. 154–155.

Acknowledgment should be made of the unfailing cooperation of the writer's companions, namely Benjamin S. Wood in 1926; Professor William S. Cooper of the University of Minnesota, with Russell Dow and Robert Stix as assistants and Thomas P. Smith as skipper, in 1935; and Dr. Donald B. Lawrence of the University of Minnesota, with Maynard M. Miller and Anthony T. Ladd as assistants and R. A. Reischl as skipper, in 1941.

[23] Reid, Glacier Bay and Its Glaciers (*op. cit.*), p. 443.

1 2 3 4

1 2 3

FIGS. 9–10—Remnant of Adams Inlet Glacier 1929–1941. 1, Granite Canyon; 2, Girdled Glacier; 3, Valley of Berg Creek; 4, Adams Glacier and Tree Mt.

Figure 9, Aerial view east from over Klotz Hills, July 18, 1929. (Photo by U. S. Navy Alaskan Survey Expedition, GS-Y12, No. 160.) Figure 10, The remnant of the Glacier and Adams Inlet from Klotz Hills, Station BB, Aug. 20, 1941. (Photo by Field, No. 41–216.)

1 2 3

FIGS. 11–12—Two views of the stagnating ice of Adams Inlet Glacier.

Figure 11, A view west-southwest over Adams Inlet from Station D, Aug. 21, 1941. (Photo by Field, No. 41–277.) 1, Shoulder of Mt. Case; 2, Entrance of Adams Inlet; 3, Pyramid Pk.

Figure 12, The moraine-covered ice at entrance to Granite Canyon from Station DD, Aug. 21, 1941. (Photo by Field, No. 41–269.)

In 1941, in three places where the ice was in contact with tidewater, embayments evidenced the far more rapid melting by this means than where the ice had been subjected only to ablation. Most of the ice was virtually motionless, but there were indications of some creep toward the unsupported tidal ice cliffs. Remnants of the medial moraines, prominent in this glacier since 1890, were still visible in 1941.

The approximate rate of surface ablation may be determined from the thinning of the ice near Station C. Here about 1300 feet of ice melted away between 1890 and 1940 so that the ice surface was lowered an average of about 26 feet a year. Since this part of the ice was almost inert, practically all of the change may be assigned to ablation.

The former limit of the distributary tongue in Endicott Gap has not yet been determined. Mature trees appear to exist in upper Endicott Valley, and the glacier could therefore not have extended far beyond the height of land separating it from Adams Inlet. Evidently this divide, shown on the Boundary Commission map (Sheet 10) as slightly more than 750 feet, blocked the flow of ice through this much nearer outlet and forced the main current of the glacier southwestward into the Muir Inlet channel.

The western terminus of Adams Inlet Glacier has had an interesting history since its separation from Muir Glacier in 1899. By 1906 recession amounted to about two miles, and another mile was added in each of the periods 1906–1913 and 1913–1931. The total of four miles in 32 years is in marked contrast with that of Muir Glacier, which in that period receded nine miles. Through 1916 the terminus was a low ice cliff characteristic of this type of glacier, which has only a slight surface gradient and is semistagnant. After 1916 an outwash plain formed in front of the terminus, which Wright reported to be one mile in length in 1931. Cooper also described the terminus as having "gone ashore." By 1935, when Endicott Lake had been drained, a tidewater channel extended through this area. Evidently the outpouring of the water impounded in the eastern part of the basin had eroded a channel through the outwash plain, and this was enlarged between 1935 and 1941 by the melting away of buried ice and continued erosion by the strong tidal currents. The depth to the bedrock floor of the valley at this point is not known, but it is possible that the great quantity of moraine and outwash deposited here since the recession of the ice has filled in what previously had been a relatively deep channel leading to the inner basin of the inlet.

To date no detailed studies have been made in upper Adams Inlet since its emergence from under the ice. The bathymetry is still undetermined, and the morainic features left by the wasting ice should be examined before

it is further modified by erosion and deposition. The several tributary valleys from which trunk glaciers have disappeared deserve attention, and they now can be easily reached.

Other Glaciers of Adams Inlet

The valleys tributary to Adams Inlet contain a number of glaciers that are remnants of former tributaries of Adams Inlet Glacier. These have not been studied in detail, but their apparent condition should be noted.

Dirt Glacier, which was wasting rapidly in the 1890's, is reported by C. W. Wright to have disappeared by 1931.

White Glacier has receded from the mouth of its valley, but the exact position of the terminus is difficult to determine from a distance because of the heavy morainic mantle. However, it obviously remains a valley glacier fed by tributaries from the ridges south and southeast of Mt. Case.

Adams Glacier, as named on the accompanying map, is an active ice stream supplied by tributary glaciers from unnamed peaks and ridges southeast of Mt. Case. It remained coalescent with Adams Inlet Glacier until the latter's breakup about 1935. However, since 1890 the contact between these glaciers had been marked by a prominent semicircular ridge of ground moraine, described by Wright in 1931 as 100 feet high, which seems to indicate that Adams Glacier supplied no actual ice to the Adams Inlet Glacier during this period. In 1941 this moraine bordered the south shore of Adams Inlet and separated the ice from tidewater. The lower part of the glacier showed signs of rapid shrinking, and its former first tributary on the east had virtually disappeared.

Aerial photographs taken in 1946 show marked recession of the terminus to a point fully a quarter of a mile behind the inlet. In front of the terminus is a large area of moraine and outwash sand and gravel, which is being rapidly dissected by stream action and transported to the delta extending into Adams Inlet. Further recession of this glacier may be expected, since insufficient ice is being supplied to the terminal section to offset the extremely heavy loss by ablation at this low elevation.

There are a number of glaciers on Mt. Young and its neighboring peaks and at the head of the valley draining into the southeast end of Adams Inlet. Glaciers also remain in the upper part of the valley of Berg Creek. These are all that are left of what must have been important feeders of the southeastern end of the Muir Glacier system a century or two ago. None of these ice tongues have been studied or named, but access to them is now simplified by the opening up of Adams Inlet.

Girdled Glacier was a tributary of Adams Inlet Glacier as late as 1935,

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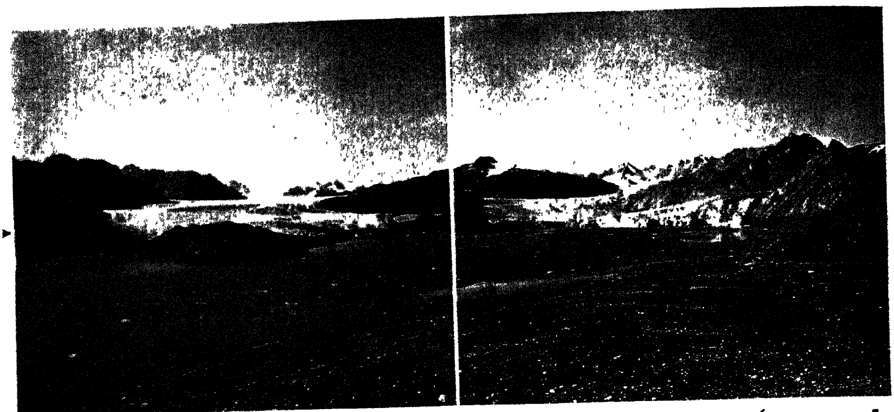

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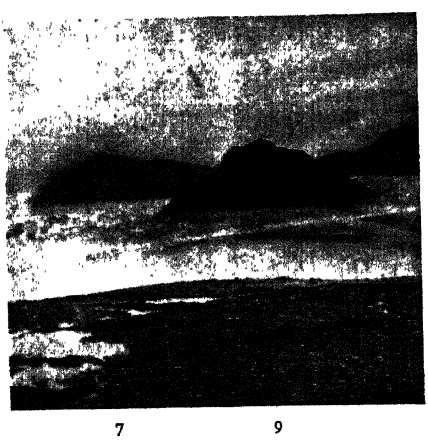

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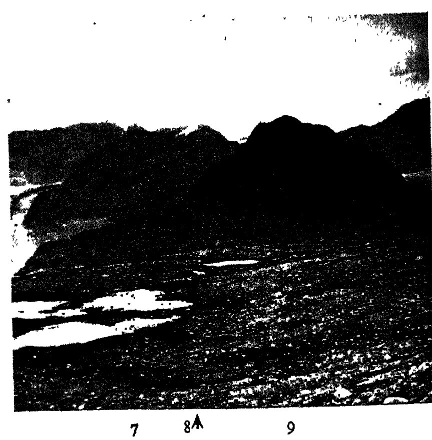

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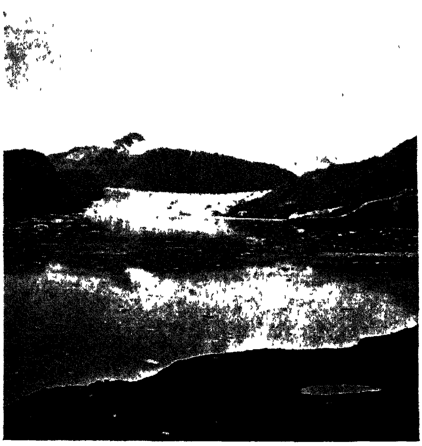
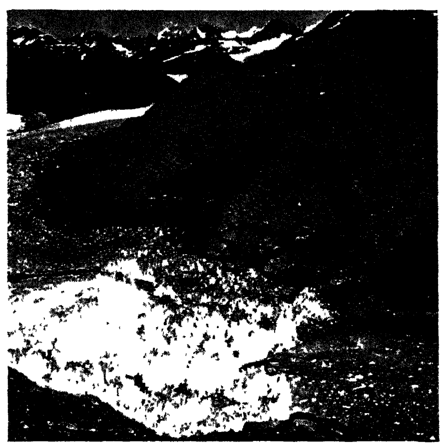
FIGS. 13–16—Muir Glacier and Nunatak Knob from Station 3. 1, Minnesota Ridge; 2, Stump Cove; 3, Site of Station 5; 4, Westdahl Pt.; 5, White Thunder Ridge; 6, McConnell Ridge; 7, Van Horn Ridge; 8, Site of Station 2; 9, Nunatak Knob.

Figure 13 (top), July, 1931 (Photo by C. W. Wright; USGS collection). Figure 14 (center), Aug. 15, 1941 (Photo by Field, Nos. 41–54 and 41–42).

Figure 15 (lower left), Sept. 3, 1926 (Photo by Field). Figure 16 (lower right), Aug. 17, 1941 (Photo by Field, No. 41–39).





FIGS. 17–20—Recession of Muir Glacier 1935 to 1946. 1, Site of Station 4; 2, White Thunder Ridge; 3, McConnell Ridge; 4, Van Horn Ridge; 5, Sealers Island; 6, Site of Station 3.

Figure 17 (top), aerial view north, Oct. 8, 1935 (Photo by Field, No. 35–143). Figure 18 (center), from Station 2, Aug. 15, 1941 (Photo by Field, No. 41–19).

Figure 19 (lower left), from Station 2, Aug. 14, 1946 (Photo by Douglas Brown). Figure 20 (lower right), from Station F on highest point of White Thunder Ridge, Aug. 15, 1946 (Photo by Douglas Brown).

although at that time the connecting ice was already largely stagnant. By 1941 the terminus had receded 1¾ miles up the valley to an elevation between 1750 and 2000 feet. Stagnant ice protected by a moraine cover still remained in the lower valley. The rapid recession can be attributed to an increase in melting caused by a warming of the local air currents after the virtual disappearance of Adams Inlet Glacier, and also to a reduced amount of ice in the névé area. As the latter is at 3500 to 4000 feet, one may conclude that snow accumulation at this elevation has substantially decreased.

The original glacier of Granite Canyon and its tributary in Howling Valley had disappeared before 1890, and this area was then occupied by a stagnant tongue of Adams Inlet Glacier. This ice has now melted away except for an insignificant remnant at the entrance to the valley. Small glaciers still occupy the cirques and higher mountain slopes, but with one exception they do not extend to low elevations. The exception is an ice tongue at the extreme east end of Granite Canyon, which still reached the valley floor in 1942 (AAF trimetrogon photograph, 1942).

The valleys on the south side of Snow Dome and Mt. Elder, which contained glaciers in 1890, are now completely ice-free. The northern slopes, however, still support small glaciers, which flow or drain into tributaries of Casement Glacier. A comparison of photographs indicates that the little summit glacier of Snow Dome, at an elevation of 4000 feet, has shrunk considerably since 1890.

Casement Glacier

Casement Glacier ceased to be an active tributary of Muir Glacier about 1911 and withdrew from tidewater shortly thereafter. By 1941 the northwest end of the terminus had receded only about four-fifths of a mile and the southeast end, which had formerly been joined with Adams Inlet Glacier, had receded more than two miles. In striking contrast the far more vigorous ice stream of Muir Glacier had receded about five miles. The reduction of the ice supply in both glaciers is probably of the same order of magnitude and the rates of surface ablation about equal, but Muir Glacier suffers additional loss from the more rapid flow of ice to the terminus and its melting by tide water.[24]

[24] Attention should be called to the misleading and unscientific term "dead glacier" widely used in Alaska to describe an ice stream such as Casement that terminates on land. This is in distinction to a "live glacier," which has a tidal ice front. If the term "dead" is to be used at all, it should refer to a stagnant remnant ice mass which as regards motion and nourishment actually approaches that state. Such an ice stream as Casement Glacier, although it terminates on land, cannot be called dead, for its ice continues to flow under the impulse of gravity in the normal way. It therefore seems advisable not to use either "dead" or "live" to describe a glacier terminus in this area; preferably it should be referred to as having a tidal front or a land terminus.

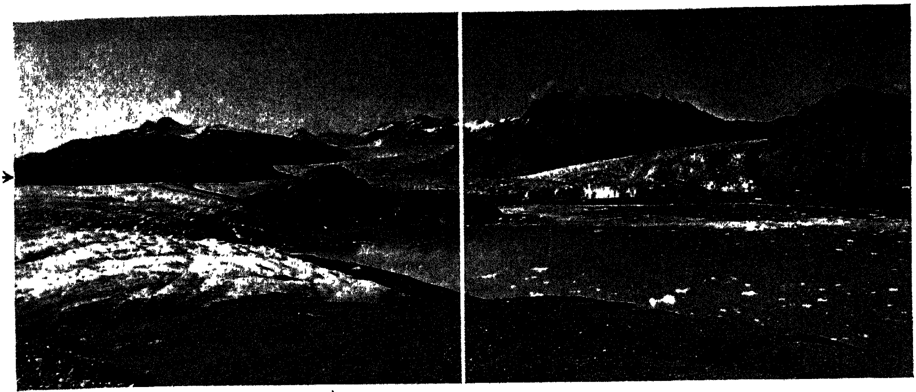


FIG. 21—Muir Glacier from Station 5, Aug. 13, 1941. 1, Remnant of Muir Glacier; 2, White Thunder Ridge and Mt. Brock in distance; 3, Site of Station 4; 4, Riggs Glacier; 5, Wolf Pt.; 6, McConnell Ridge and McBride Glacier; 7, Van Horn Ridge. (Photo by Field, No. 41–89 and 41–90.)

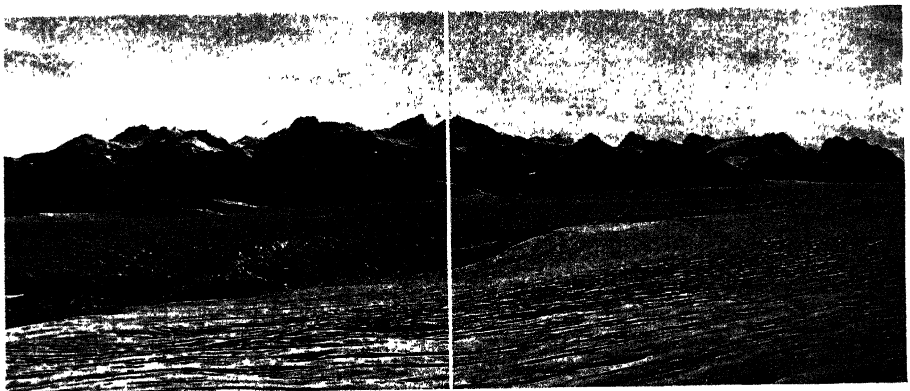


FIG. 22— Plateau Glacier and mountains to the southwest from Station 7, Aug. 19, 1941. Burroughs Glacier ice in foreground. 1, Head of Wisconsin Inlet; 2, Mt. Kloh-Kutz; 3, Patton Glacier and Mt. Cadell; 4, Mt. Merriam; 5, Andrews Glacier; 6, Baldwin Glacier; 5 to 6, Emerson Pks. in distance; 7, Mt. Wordie; 8, Loomis Glacier. (Photo by Field, No. 41–141 and 41–142.)

FIG. 23—Casement Glacier showing moraine pattern near terminus. Aerial view northeast from over Muir Inlet, Oct. 8, 1935. 1, Forest Creek. (Photo by Field, No. 35–142.)

FIG. 24—Plateau Glacier and Wisconsin Inlet. Aerial view northeast; Muir Glacier and Inlet in middle distance, Oct. 8, 1935. Arrows indicate Station 7. (Photo by Field, No. 35–146.)

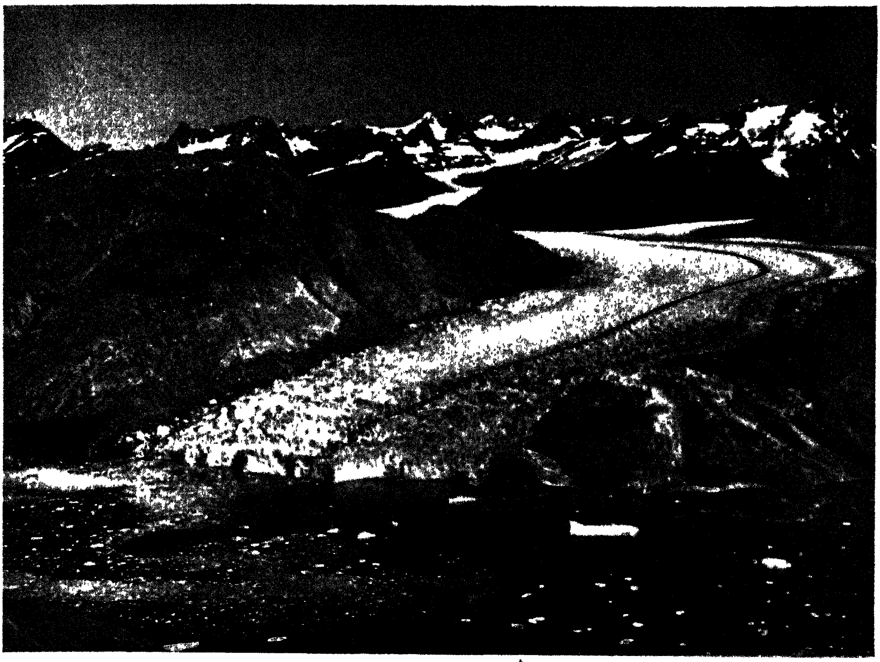
Casement Glacier, with an area of 50 to 60 square miles, derives its ice from an extensive névé basin. This basin, at an elevation of 3000 to 5000 feet, receives numerous tributary glaciers from the higher surrounding ridges and, at about 5000 feet, forms a through glacier relationship with Davidson Glacier which flows eastward into the fiord called Lynn Canal. The condition of the small tributaries from the four valleys north of Snow Dome and Mt. Elder is not known, but the course of their medial moraines indicates that little ice is now received from these sources.

The relationship of the ice drainage between Casement and Davidson Glaciers is not known except for the fact that their névé basins are continuous. Ice shrinkage on the Casement side is far greater than on the Davidson side, a condition which suggests that within the last few hundred years certain factors favorable to glacier expansion followed by rapid recession have occurred primarily on the Glacier Bay side of the watershed.

A comparison of the photographs taken by Reid in 1892 with those of recent years shows no very great change in the upper part of the glacier. The 3250-foot contour on Reid's map coincides with the 3000-foot contour on the 1941 map. Below 3000 feet recession of the terminus has steepened the surface of the glacier from an average gradient of about 175 feet to a mile in 1892 to about 225 feet in 1941. At the position of the terminus in 1941, the surface of the ice in 1907 was at about 1000 feet and in 1892 at 1100–1200 feet. Thus at the 3000-foot elevation the lowering of the ice surface averaged about five feet a year from 1892 to 1941, and at the present terminus about 22 feet a year from 1907 to 1941.

The medial moraines in the lower part of the glacier (Fig. 23) are of interest because of their sinuous course, which suggests that the ice meets increasing resistance by slower-moving or stagnant ice at the terminus and becomes compressed into horizontal folds without apparent fracture. This type of differential movement in the ice seems to occur in relatively slow-moving glaciers of low gradient where a large amount of moraine in the ice and around the terminus retards the normal flow down the valley.[25]

[25] Certain aspects of the plasticity of ice are not yet fully explained. According to a personal communication from F. E. Matthes "Plasticity of the lower layers and the rate of movement are functions of the thickness (and weight) of the ice mass. Consequently, a gradual thinning of the ice toward the terminus results in a relatively rapid loss of plasticity and slowing up of forward movement. The thick, rapidly moving ice in the main body of the ice stream therefore finds its way obstructed by the thinner and slower-moving ice in front of it. This situation results in S curves in the flow, most prominently revealed by the dark medial moraines. But when viewed at close range the apparently smooth curves are found to be cleft by innumerable small shear planes. These are cases of 'obstructed flow' according to Demorest's concept [Max Demorest: Ice Sheets, *Bull. Geol. Soc. of America*, Vol. 54, 1943, pp. 363–399.]"



1 2 3 4

FIG. 25—McBride Glacier. Aerial view northeast, Aug. 15, 1946. 1, McConnell Ridge; 2, Site of Station E; 3, Rocks appearing at ice front in 1941; 4, Sitth-gha-ee Pk. (Photo by William Latady.)

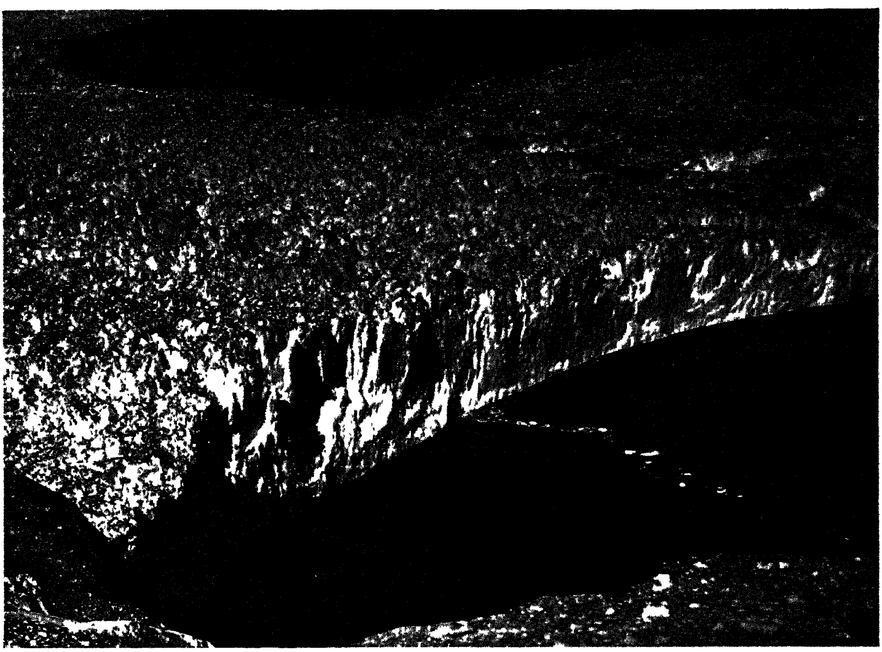


FIG. 26—Muir Glacier terminus from Station 4, Aug. 13, 1941. Ice front rises to maximum height of 265 feet above water. Riggs Glacier at upper left, McBride Glacier at right. (Photo by Field, No. 41-65.)

McBride Glacier

In 1941 McBride Glacier still coalesced with Muir Glacier to form a single ice front. However, between 1942 and 1945 the Muir terminus receded past the front of McBride Glacier, which thus became independent. In 1946 McBride Glacier with its tributaries had an area of about 46 square miles, and its principal sources were tributaries draining from basins at 3000 to 5000 feet among peaks of 6000 and 7000 feet.

Above the terminal icefall the surface of the glacier everywhere is higher than 1250 feet, so that loss by ablation is less than on the corresponding areas of Casement Glacier and other tongues at lower elevations. Reid's map and photographs of 1892 show the glacier flowing over the highest point of Van Horn Ridge, which is at 2100 feet (Fig. 6). By 1907 this point had emerged from the ice, but a shoulder about 1880 feet in height was still covered. Ice continued to flow across the lowest depression on the ridge, at 1500 to 1600 feet, until sometime between 1926 (Field) and 1929 (U. S. Navy aerial photographs). Since then the ice surface at this point has been lowered about 200 feet more, making the total since 1892 about 800 feet or an average of about 15 feet a year. Continued shrinkage would soon be apparent at the terminus, where rock is already emerging from beneath the ice at the south side.

On the east side of upper Muir Inlet is a large mass of stagnant ice which is a remnant of the McBride ice stream (Fig. 29) that formerly flowed over Van Horn Ridge. It has received no nourishment since sometime before 1929, but it had the lateral support of Muir Glacier on its west side until 1937. In 1941 this glacier had an area of 4.8 square miles and a surface sloping from slightly over 750 feet to less than 250 feet. At the latter point, a rough estimate would place the lowering of the surface from 1907 to 1941 at about 750 feet, or an average of about 22 feet a year. This would be almost entirely due to ablation. Local crevassing east of Anchorage Cove indicates that there has been some lateral movement of ice into this depression. The migration from their original positions of the medial moraines which formerly extended down-glacier from Van Horn Ridge and the slopes of Coleman Peak also indicates the slow creep of this ice mass. Though the thickness of this ice has not yet been determined, the floor of its basin is very likely below sea level.

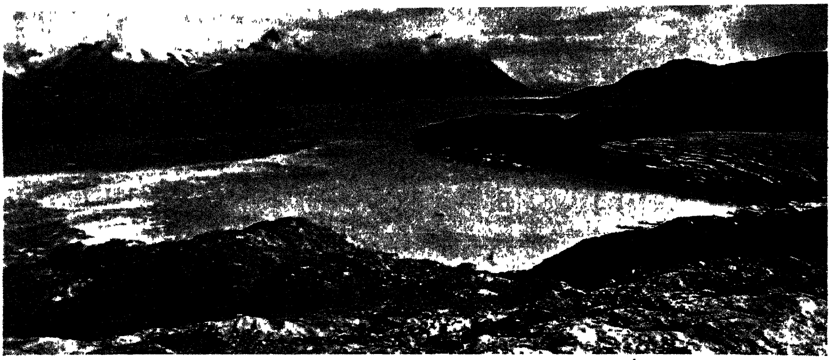
A former tributary of this glacier still occupies a cirque at the western base of Coleman Peak, where it is shrinking rapidly and will probably soon disappear.

Muir Glacier

As the principal ice stream of the inlet, Muir Glacier has dominated the recent glacial history of this drainage basin. Its recession has been far more rapid than that of any of the other glaciers which are nourished by névé areas and active tributaries, and this rapid recession has tended to accelerate the recession or disappearance of its tributaries by admitting tidewater to their termini and increasing their areas subject to ablation and marginal melting. Measured from the upper end of its snow field the glacier is now about 20 miles long, whereas as late as 1899 it was fully 33 miles long. Its reduction in area is less clearly defined, because former tributaries are now independent glaciers and whatever shrinkage has occurred in the névé basin has been primarily vertical. In 1946 Muir Glacier covered about 129 square miles, of which its principal tributary, Riggs Glacier, occupied about 44 square miles. A further recession of the terminus of less than two miles would cause Riggs Glacier to become an independent ice stream, though still joined with the Muir in the névé area.

The behavior of Muir Glacier before 1913 has been summarized by several observers (Martin, 1913; Cooper, 1923, 1931, and 1937; and Andrews, 1931). The rapid recession that began in 1899 ended about 1907. Significantly, during this period the terminus was receding along a broad part of the inlet with depths of more than a thousand feet, so that a relatively large area of terminal ice was exposed to melting by tidewater. From 1907 to 1946 the terminus receded seven miles, as is shown on Inset Map A (Pl. I). It is evident that the rate of this recession has been influenced largely by two factors: the extent of the terminal ice exposed to tidewater as determined by the depth of the inlet and the length of the tidal ice cliff, and the degree of lateral constriction of the ice stream at the terminus either by the basal topography or by the pressure of a tributary glacier.

Of special interest is the behavior of the terminus from 1926 to 1931. Gradual recession along the rocks of Westdahl Point is apparent in the photographs taken in 1926, 1929, and 1931, but the eastern half of the ice front advanced 400 to 500 yards between 1926 and 1929 and then by 1931 had receded slightly behind the 1926 position. Such an advance may be due either to a minor surge in that part of the ice stream or to a variation in the rate of melting at the terminus. Because of the shallowness and constriction of Muir Inlet at this point, any slight increase in the vigor of the ice stream might have been able to cause an advance, whereas had conditions favored more rapid recession, the same impulse might hardly have been noticeable.

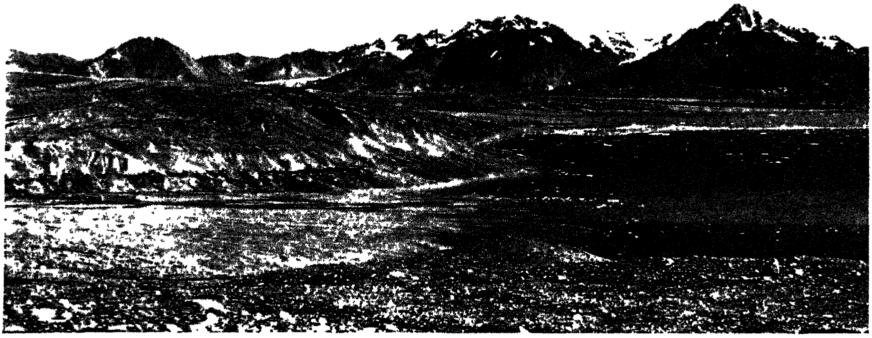


1 2 3 4 5 6 7

FIG. 27—View down Muir Inlet from Station 4, Aug. 15, 1941. 1, White Glacier; 2, Mt. Case; 3, Sealers Island; 4, Westdahl Pt. and Mt. Wright; 5, Site of Station 5; 6, Knob G; 7, Remnant of Muir Glacier and Minnesota Ridge beyond. (Photo by Field, No. 41–68.)

FIG. 28—Remnant of Muir Glacier. View west from Station 4, Aug. 15, 1941. Minnesota Ridge and Glacier Pass in background. (Photo by Field, No. 41–70.)

FIG. 29—View southeast from White Thunder Ridge south of Station 4, Aug. 13, 1941. Stagnant ice in foreground, remnant of McBride Glacier in distance, and Nunatak Knob at right. Arrow indicates Station 6. (Photo by Field, No. 41–56.)



1 2 3 4 5

FIG. 30—View southeast toward Adams Inlet from Station 3, Aug. 15, 1941. 1, Casement Glacier; 2, Tree Mt.; 3, Adams Glacier; 4, White Glacier; 5, Klotz Hills in middle distance and Mt. Case beyond. (Photo by Field, No. 41–49.)

FIG. 31—Nunatak Knob and remnant of McBride Glacier from Station 6, Aug. 14, 1941. Mt. Case at left and Muir Inlet at right. (Photo by Field, No. 41–110.)

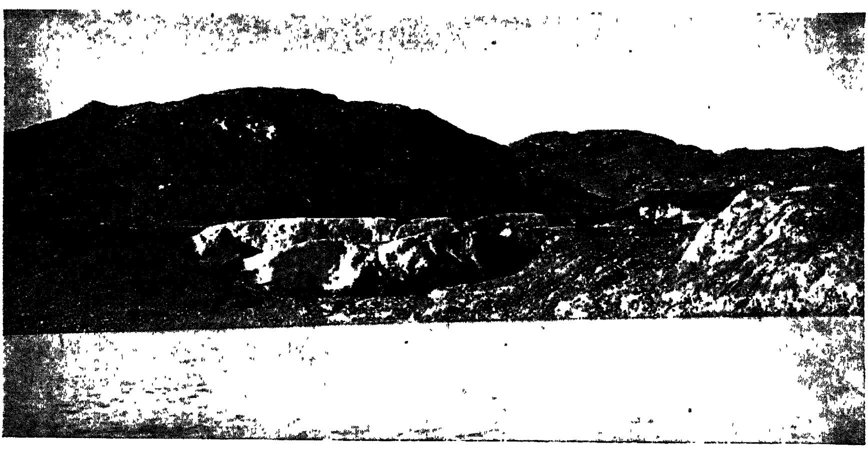


FIG. 32—Remnant ice near Wolf Pt. in Upper Muir Inlet, Aug. 13, 1941. The terminus receded past this point about four years earlier. (Photo by Field, No. 41–55.)

Melting at the terminus in the months preceding the date of observation in early September, 1926, was probably excessive, for the average air temperatures then were among the highest ever recorded in Southeastern Alaska. Recession might therefore have been greater than normal and have been followed by a compensating advance during the ensuing cooler years.

It would be desirable to know to what extent the surface of the upper névé areas has been lowered during the past few decades, but unfortunately there are no reliable data on this point. From a comparison of long-distance photographs it would seem that no very great changes have occurred above 3500 feet. Reid's 3000-foot contour in 1892 is in approximately the position of the 2500-foot contour in 1907 (Boundary Commission) and the 2250-foot contour in 1941. At a point west of McConnell Ridge the level of the ice has been: 1892, 2250–2500 feet; 1907, 1750–2000 feet; 1941, 1000 feet; and 1946, terminus. A mile and three-quarters below this, west of Van Horn Ridge, the corresponding figures are: 1892, 2000 feet; 1907, 1500 feet; 1941, terminus. Thus the difference in elevation between 1892 and 1941 is progressively greater from the névé areas toward the terminus, so that the average gradient of the ice surface from points east and west of Mt. Brock has steepened from about 150 feet to a mile in 1892 to 190 feet in 1907, 250 feet in 1941, and probably more than 300 feet in 1946. This may be compared with the gradient during the eighteenth-century maximum, which appears to have been about 30 to 40 feet to a mile in this area.[26]

The lowering of the ice surface of Muir Glacier, unlike that of the surface of Casement and the stagnating glaciers, is due both to ablation and to flow of ice to lower levels. The rate of 38 feet a year from 1907 to 1941 near the position of the 1941 terminus and of 100 feet a year from 1941 to 1946 at the 1946 terminus indicates how greatly lowering of the surface may vary and the extent to which flow may account for it (i.e. the excess over the approximate rate of 25 feet a year assigned to ablation of more or less inert ice near sea level).

In 1941 the highest section of the ice front was found to be 265 feet. This is rarely exceeded among Alaskan tidal glaciers and seems to be the maximum height above tide at which an ice cliff can stand without collapsing. If very heavy tidewater melting causes substantial recession of the terminus, the ice cliff is not thereby increased in height above this maximum but the lower end of the glacier tends to collapse toward the terminus in great steps separated by transverse crevasses, with the result that the surface gradient is steepened and the ice front remains about the same height.

[26] Cooper, The Problem of Glacier Bay (*op. cit.*), p. 46.

During the last 15 to 20 years the Muir terminus has been one of the most spectacular and active along the Alaskan coast. In 1926 one could see great falls of ice from as far as Camp Muir, 11 miles away, and hear the thundering roar nearly 50 seconds later. Since the terminus of Muir Glacier has been compressed in a relatively narrow channel during the last two decades, the ice front is more compact than in most glaciers and much of the discharge is composed of large transverse sections or slabs, which either fall vertically into the inlet to reappear almost to their original height or collapse outward and shatter into smaller pieces. In 1941 huge masses of deep-blue ice were seen to rise from the depths of the inlet fully 200 yards from the ice front. The icefalls observed that year during the survey in the upper part of the inlet were the largest any member of the party had seen in Alaska. On one occasion a section some 300 yards long gave way in the center of the ice cliff and started a series of falls and submarine discharges that continued for a minute and a half. A boat would have been in danger within a half mile of the ice front. The 1946 ice cliff was narrower but still had the appearance of great activity. Immense transverse crevasses gashed the last quarter mile the glacier where the ice was collapsing in great steps toward the unsupported ice cliff (Fig. 20).

In 1941 Muir Glacier was supplying little ice to the area between White Thunder Ridge and Minnesota Ridge, so that this distributary tongue of about eight square miles was already thinning to the point of becoming stagnant. By 1946 its nourishment had been cut off entirely.

Plateau and Burroughs Glaciers

These two glaciers may be considered together, since they are remnants of what Reid originally called the Cushing Plateau but what with some confusion has since been referred to both by this name and as Plateau Glacier. In 1941 Burroughs Glacier had an area of about 16 square miles and Plateau Glacier and its tributaries had about 33 square miles. In 1890 these glaciers were already stranded between the main currents of Muir and Carroll Glaciers. The recession of Carroll Glacier and the emergence of Minnesota Ridge had effectively cut off the main source of supply from the north and northwest, and the maximum elevation was already below the summer snow line. The ice surface was being lowered by ablation and by the flow of ice outward toward the peripheral depressions. Recession of the tidal ice cliff in Wisconsin Inlet amounted to 2½ miles from 1913 to 1941, and by 1946 the inlet had been extended an estimated additional mile and a half (Brown, 1946). Here the waters of the inlet have eaten into the heart of Plateau Glacier

with startling rapidity, and an extensive embayment has been formed reaching almost to the base of Idaho Ridge. Despite some nourishment received from tributary glaciers to the southwest, Plateau Glacier has shrunk more rapidly than Burroughs Glacier because of the more rapid flow of ice toward this very active ice front in Wisconsin Inlet.

The distributary ice tongue on the west side of Muir Inlet between Minnesota Ridge and Curtis Hills was a tributary of Muir Glacier until 1920, and its subsequent recession from the inlet by 1941 amounted to only about three-eighths of a mile horizontally and 350 feet vertically. Although its recession is slow, it is being rapidly thinned by ablation and no longer appears to drain much ice from Burroughs Glacier. The latter's main southward flow is now into Plateau Glacier through a depression between Curtis Hills and Bruce Hills.

The lowering of the ice surface in the highest part of Plateau Glacier has amounted to about 750 feet since 1892, or an average of about 15 feet a year. On the highest point of Burroughs Glacier, about 2000 feet, the surface has been lowered some 250 to 500 feet, or about 5 to 10 feet a year. The indications are that Plateau Glacier will continue to shrink more rapidly than Burroughs Glacier and that a development somewhat similar to that in Adams Inlet may be expected in the next decades. Burroughs Glacier, though subject to considerable ablation, which will cause gradual shrinkage, may continue to exist considerably longer because it is at a greater elevation and the ice is not flowing away as rapidly at the margins.

On the southwest side of Plateau Glacier are four valley glaciers that have not previously been mapped. Three of these, Loomis, Baldwin, and Andrews Glaciers, with a combined area of six to seven square miles, are tributaries of Plateau Glacier. As its surface continues to be lowered, these glaciers will form their own separate termini at points above sea level along the side of Wisconsin Inlet or the valley at its head. The fourth, Patton Glacier, terminates within its own valley, but masses of stagnant ice seen in the lower part of the valley in 1941 indicate that it has changed from a tributary status comparatively recently.

Morse Glacier, which was a tributary of Muir Glacier until sometime between 1890 and 1892 and was connected with Plateau Glacier until sometime after 1907, has shrunk enormously. Its terminus now seems to be somewhat more than two miles from the inlet, at an elevation estimated to be about 500 feet. However, precise observations are lacking.

Dying Glacier, named by Reid, in the valley between lower Muir Inlet

and Tidal Inlet, no longer exists, though remnants of its ice were still visible in 1946. The name Ice Valley is therefore suggested to recall this glacier.

General Trends

One would wish that this record of ice recession could be correlated with meteorological observations in the immediate vicinity of Muir Inlet. However, the only available data are from stations at Haines, Skagway, Juneau, Sitka, and Yakutat which are from 30 to 140 miles away and at sea level. These do not record the local changes in temperature and precipitation in Muir Inlet or conditions in the areas of snow accumulation at 3000 to 6000 feet elevation.

Since the eighteenth century the general trend has been one of recession, which as it has progressed has uncovered large areas of bare land and lowered the surface of existing glaciers which, in turn, has accelerated melting and reduced the annual rate of precipitation in the form of snow. Although some glaciers in the northwestern part of Glacier Bay appear to have reached a semblance of equilibrium between accumulation and wasting during the past twenty years, this is not true of the Muir Inlet area, where recession is continuing.

Although adequate data are not available, it seems clear that the summer snow line on the glaciers (firn line) has been rising. It now appears to be, on an average, above 3000 feet. Glaciers nourished from névé areas between 3000 and 5000 feet are shrinking, so that one may infer that snow accumulation up to at least 5000 feet is being reduced. Since this zone must have been the primary source of nourishment for the expanded glaciers of the eighteenth-century maximum, it seems likely that an important rise in the level of maximum snowfall has taken place in this area. Such a trend has also been observed in the glaciers of Prince Willian Sound, some 400 miles to the west-northwest.[27]

Along with the decrease in snowfall and the gradual shrinkage of the ice, it may be assumed that the mean summer temperatures in Muir Inlet have been rising. As has been noted in the preceding pages, during the past few decades surface ablation below the 1000-foot level has averaged about 26 feet a year at Adams Inlet Glacier and 22 feet a year at Casement Glacier and the remnant of McBride Glacier. Between the 1000- and 2000-foot levels surface ablation, plus some flow, accounted for an average

[27] Report of Committee on Glaciers, 1935–36, François E. Matthes, Chairman, *Trans. Amer. Geophysical Union, Seventeenth Ann. Meeting, 1936,* Part 2, Washington, 1936, pp. 286–294.

lowering of the ice surface of 15 feet a year at both McBride and Plateau Glaciers. At about 2000 feet on Burroughs Glacier the surface has been lowered about 5 to 10 feet annually, and at 3000 feet on Casement Glacier about 5 feet. This represents a rough estimate of the degree of surface ablation at these elevations during this period.

From the data at hand it is obvious that glaciers which terminate in tidewater have undergone the greatest change. This may be attributed to the fact that they are subject to the three factors of surface ablation, melting by tidewater, and rapid flow of ice in the glacier above the terminus. These combine to cause the most rapid lowering of the ice surface and the greatest recession of the termini. Only an ice stream of great vigor can still flow to sea level in Muir Inlet, and all such tidal glaciers are now receding rapidly. If the present rate of recession is maintained, they may cease to be tidal within the next few decades.

Need for Systematic Investigation

For the study of the causes and effects of the variations of glaciers, probably no other area in the world can compare with the coast of Southeastern Alaska. Moreover, it is comparatively easy of access and well mapped topographically; it has an essentially temperate climate; and the record of observations both glaciologic and meteorologic goes back further than for any other part of the large glacial areas of North America. A comprehensive study calls for a systematic long-term program covering the various aspects of glaciologic research.

In addition to new field studies, much information may yet be gleaned from unpublished data, such as manuscript notes and sketches or photographs made by visitors since Vancouver's time. There still remains the possibility of finding unpublished notes of Russian travelers or persons of other nationalities who were in the vicinity before 1880. Between that date and 1900 it is estimated that fully 5000 persons visited Muir Inlet on excursion steamers and a few hundred have been there since. Among their records, no doubt, are photographs and data of potential interest which would be most welcome.

An invitation to participate in this work is also extended to future travelers in the region. Photographs of ice tongues showing their general appearance and the positions of their termini relative to other recognizable topographic features are always useful. If the glaciers have been previously photographed, the new pictures should if possible be taken from the same spot. If former photographic stations do not exist or cannot be reached,

new stations should be established and marked with a prominent cairn so that they may be visited in the future. By comparing photographs taken from the same location, even slight changes may be detected in the volume or length of a glacier and in such other features as erosion, deposition, and growth of vegetation. By no means is this interest confined to the large and spectacular glaciers: most emphatically, it also includes small summit and cirque glaciers, whose variations are even more sensitive indicators of local change. Information may be obtained before going to an area where there are glaciers as to what studies have been made and whether photographic stations have already been established there.

Photographs, old and new, and explanatory notes, including the station location and date, should be sent to the writer at the American Geographical Society, Broadway at 156th Street, New York 32, N. Y., where are maintained the Society's permanent files and those of the Research Committee on Glaciers of the American Geophysical Union.

COCONUTS IN THE RUSSELL ISLANDS

CHARLES M. DAVIS

THE RUSSELL ISLANDS, a small group in the southern Solomons (Fig. 1), have been the site of an extensive copra industry for nearly half a century. Commercial coconut plantations date from about 1900, when two planters established themselves on Banika Island—Captain Svensen at Banika Plantation on the north shore of Renard Sound, and Billy Pope at Yandina Plantation on the south shore. A few years later Lever Brothers, the largest soapmaking firm in the British Empire and one of the most powerful and widespread corporations in the world, prospected the islands for favorable plantation sites. In 1907, representatives of the firm bought Captain Svensen's plantation as a nucleus for their holdings. Since then, they have established plantations on the north shore of Pavuvu Island at Somata, West Bay, Kaylan, and Pepesala and have enlarged the plantation on Banika until it occupies most of the northern half of that island. The islets of Kokia, Faielau, and Ufa were also developed.

Two other corporations were prospecting at the same time for plantation land in the Solomons—Burns, Philp and Company Ltd., and the Malaita Company. The Malaita Company bought Yandina Plantation from Pope while the Levers were acquiring Banika and later extended it to include nearly all the southern part of the island except for the hill lands surrounding a small volcanic cone; the islet of Talina was likewise cleared and planted. Shortly before 1940 the Malaita Company disposed of its holdings to the Fairymead Sugar Company, which now operates the plantation.

Altogether, there are now some 12,000 acres of coconuts under cultivation in the islands,[1] in addition to a strip of native planting around the principal village of the group, on Loun Islet. The development of the Russell Islands as the chief producing area of the Solomons has been based on several circumstances, among the most important of which are certain physical characteristics of the land, adequate anchorages, availability of acreage under the land laws of the Protectorate, and a near-by labor supply.

Physical Conditions

The Russell group consists of two principal islands, Pavuvu and Banika, with a fringe of smaller islets and reefs on three sides (Fig. 1). The islands form part of the southern geanticline of the rising volcanic Solomon chain.

[1] Figure derived from planimeter measurements of a Hasty Terrain Map made from aerial photographs by the Eighteenth Marine Engineers, 2d Marine Division, under combat conditions.

Most of Pavuvu, the larger island, is occupied by the cones and spurs of Mt. Pavuvu, 1600 feet high. From their crests the slopes descend at approximately a 25 per cent grade to 300 feet. Below this level the slopes are gentle, and the mountainous topography is replaced by the smoother surface of the coral terraces that reach to the coast. On the southwest side of the island the 300-foot elevation extends to the coast, where it terminates in sea cliffs; Mone Islet, cliffed and slightly lower, is a detached portion of this surface. On the north side of the island, however, from West Bay to Sunlight Channel, a series of broad terraces blend into a smooth slope between the mountain and the sea. On the lower terrace plains the coconut plantations have been established.

On Banika, the smaller of the two principal islands, two relatively low elevations are probably, but not obviously, volcanic outlets. The higher of these, in the southern part of the island, rises to barely 400 feet, and the smaller, north of Renard Sound, to less than 300 feet. The coral terrace is everywhere low, and there are no cliffed coasts. Most of the island surface is occupied by the two large plantations. The islets surrounding Pavuvu and Banika partake of the nature of the coast off which they lie. The northern ones, from Kolokula to Kaukau, are *motus*—coral piles broken by the waves and tossed on the edges of the reefs. From Kokia south to Loun the islets are low coral platforms separated from the principal islands by water 200 feet deep or more.

The low terraces that provide the best sites for plantations are underlain by coral deposits of great depth. American forces quarrying for road-building material during the war came upon ground water at about 40 feet, but nowhere did they reach the lava rock that, according to the theory of volcanic-island structure, should lie below the coral. The coral deposit is said by plantation men to extend up the volcanic slopes of Mt. Pavuvu to a thousand feet above the sea, or more. At these high levels it is eroded into gullies, described as floored with a "dark, hard rock," possibly andesitic lava laid down in the earlier stages of mountain building. On Banika Island coral now covers the two low hills that may have been volcanic outlets. The weathering of the coral seems to have smoothed minor elevations and depressions on the terraces, producing an almost level or gently sloping surface, on which the coconut plantings have been laid out.

The terraces are covered with a heavy, black, friable soil ranging in depth from five feet on the level surfaces to two feet over the hills. In quarries and road cuts it is seen to lie directly on the coral, which is discolored for several inches below the soil line. The soil contains many coral frag-

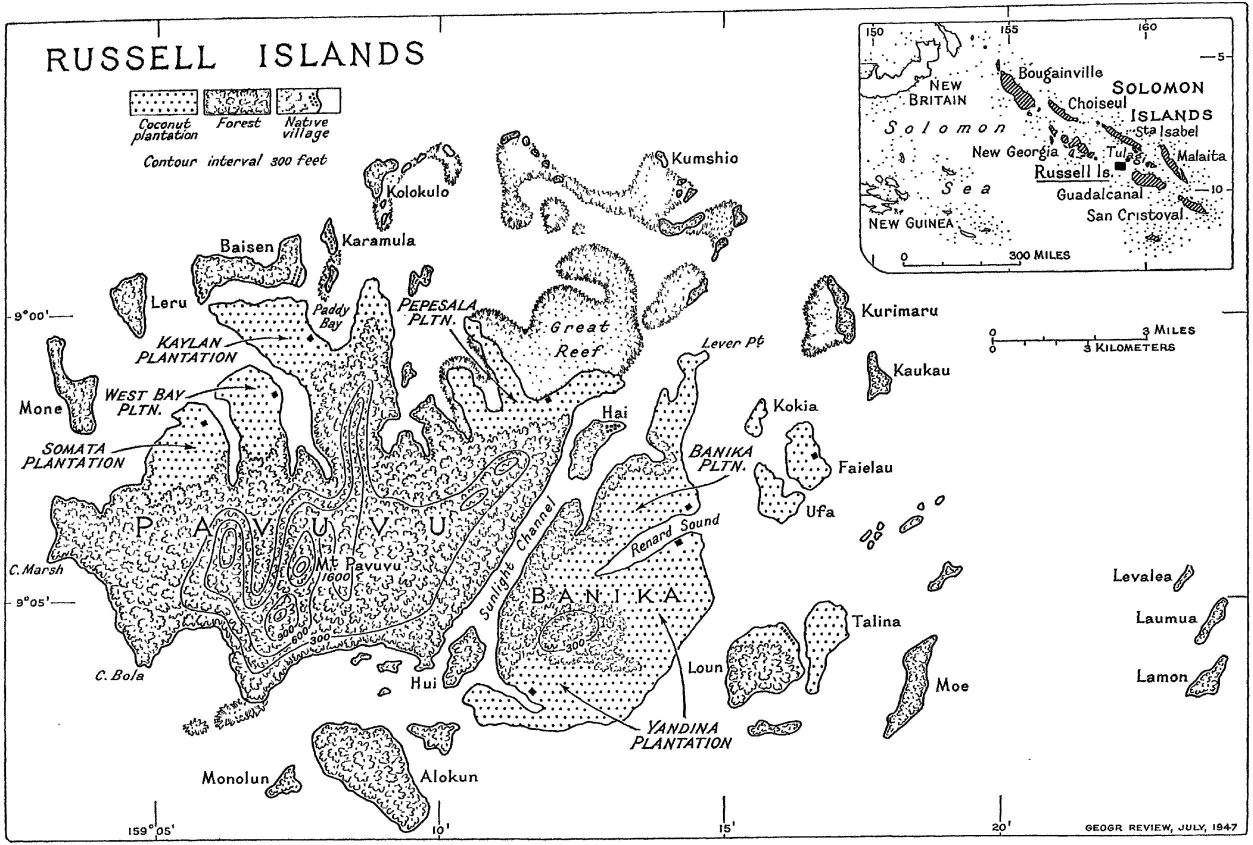


FIG. 1—The coconut plantations of the Russell Islands. The inset shows the position of the group in the Solomon Islands chain.

Fig. 2—Natural vegetation on a coastal coral terrace: the fringing coral reef, narrow strip of iungle vegetation, heavy tropical forest. (Photograph by AAF.)

Fig. 3—Plantation workers on Banika Island. The native standing in the center holds a copra knife. The white men are American service personnel.

Fig. 4—Pattern of coconut palms on Banika Plantation. Between rows is a supply dump of the American forces.

ments, especially in the lower part, and seems to be, in the absence of definitive tests, a rendzina derived from weathering of the coral. Its suitability for coconuts has been demonstrated: the Russell Island plantations are said to produce the highest yields per acre in the Solomons. Its durability under cultivation has also been proved. In contrast, yields of the Guadalcanal plantations, established about the same time as those on the Russells, have been decreasing, and more cultivation, together with the application of fertilizers, is required in order to maintain a profitable growth of palms.

Anchorages

Along the cliffed coast of southern and western Pavuvu there are no places where large ships can anchor close to shore, and in any case the constant heavy surf would endanger operations by lighter. Along the north and east coasts the fringing coral is a hazard, but there are several places where ships can anchor in protected waters and where there are openings through the reefs large enough for small boats. The plantation headquarters are located at such places. The arms of West Bay provide shelter for vessels servicing Somata and West Bay Plantations, and Pepesala Plantation, on the north shore, is protected by reefs and islets. The deep-water passage of Sunlight Channel, although it affords good anchorage, seems to be little used, perhaps because most of the plantation headquarters are located near the outer shore of the islands to obtain the advantage of the ocean breeze. In Renard Sound, off Yandina Plantation, there is a concrete wharf, one of the four places in the Solomons where ordinary ocean-going vessels can tie up alongside.

Availability of Land

Before 1893 the 50 or so white residents of the Solomons acquired considerable land from the natives, mostly for trivial considerations. As a part of the establishment of the British Protectorate in that year, the Solomon Land Regulations provided that, although these earlier acquisitions should be recognized and legalized, no additional land might be purchased directly from the natives. Since that time all plantation land is held on lease, either from the natives, with the government acting on their behalf, or from the government, which may acquire land by alienation or purchase from the native owners if there are any. In either case, and especially in the latter, the land to be used for plantations must not be taken from that necessary to the native garden economy. The Protectorate officials seem to have been most conscientious in enforcing this provision.

It is probable that the Russell Islands were never so heavily populated as the larger islands of Guadalcanal, New Georgia, and Santa Isabel, despite the abundance of flat garden land; and by the latter part of the last century the population of the Russells had nearly died out. The cause of the decline is not known with certainty; it may probably be attributed to the generally deleterious contacts of Pacific islanders with white people during the latter half of the nineteenth century. The few remaining villages were situated in their present locations on the islets of Baisen, Karamula, and Loun. Some 20,000 acres of desirable land on the nearly deserted islands were therefore available for alienation as crown land and for subsequent lease to planters. The rentals under such leases are nominal: three pence an acre for the first five years, six pence for the second five years, one shilling from the eleventh year to the thirty-third, and so on, advancing to three shillings an acre after 66 years. As the expectable annual profit on coconut plantings is 5 to 15 pounds sterling an acre, according to the fertility of the land and the market price of copra, rental is of little importance in total production costs.

Labor Supply

Under the Native Labour Regulations of the Solomon Islands the recruiting and employment of natives for plantation work are carefully controlled. The rights of both the employer and the employee are specified in detail, and the provisions are strictly enforced by the British civil servants. Most of the natives are brought to the Russell plantations from the coastal villages of densely populated Malaita, by licensed and registered recruiting ships. Only young men are desired, and wives and children are not ordinarily taken along. In return for a bundle of presents—knives, tobacco, cloth, and trinkets for his family and friends—a boy is induced to sign for a two-year indenture. After this period he may be returned to his home at the planter's expense, but many of the boys stay on for another year or two, perhaps even for ten. When they do return, however, they are much changed. The ignorant village youth is now a sophisticated man who has seen the world from Tulagi to Guadalcanal and has brought home a wealth of shillings, waistcloths, perfumed water, and singing alarm clocks. These returning veterans from the plantations, with their impressive smattering of the white man's culture, are the envy of the country bumpkin, the "boy belong bush," who stayed at home. Notwithstanding the exodus of the young men, few plantations in the Solomons have ever had as much labor as they could utilize, and many planters believe that the indigenous population can no longer furnish enough workers to maintain the industry at its present level.

The Russell group is 30 miles from the north end of Guadalcanal, more than a hundred miles from Malaita, and 70 miles from Tulagi, the capital of the Protectorate, where all laborers must go for official signing and registration before being delivered to the plantations (Fig. 1). From Tulagi they are either delivered to the plantations by recruiters or brought by the planter himself. In either case the transportation costs are insignificant. The responsibilities of the planter to his boy are food, clothing, shelter, medical attention, and eventual return to his home. For his part, the boy agrees to perform a specific amount of work. The planters are interested in the native primarily as a source of labor and are only secondarily concerned with his progress toward a higher civilization and a healthier body. One commentator probably expressed the general feeling when he wrote: "As soon as the natives here are made to work the healthier they will be, and the less call there will be for the expenditure of the Government on large quantities of medicine for the curing of native ailments, which are nothing more than pure laziness."[2] Even the minimum standards of diet and housing provided by the Labour Regulations keep the plantation boys in excellent condition (Fig. 3), much healthier than the village natives, whose diet is inferior. There are many advantages in an isolated location such as that of the Russells, away from native villages. On plantations on the larger islands in the Solomons the boys commonly spend their Sunday holiday in native villages and are willing to walk miles to do so. On Monday many are tired; a few may be missing. The plantation boys are likely to pick up dysentery and other diseases in the villages or to become involved in brawls. Planters who in the beginning located near villages to obtain a labor supply now consider a near-by settlement to be a nuisance.

Development of the Plantation

One of the largest expenses in the establishment of a plantation is that of clearing the site. The fertile terraces are covered with a heavy tropical forest (Fig. 4), which must be completely removed. During the war, American servicemen were able to clear such land with amazing speed: bulldozers pushed out the trees; graders, plows, and drags smoothed the surface. But for the native, who has only ax, shovel, and knife, it is a long and laborious undertaking. The land along the shore is ordinarily not cleared for cultivation, so that narrow strips of mangrove and rain forest fringe the plantings.

[2] From the Rabaul *Times* of March 22, 1929, as quoted in H. I. Hogbin and Camilla Wedgwood: Native Welfare in the Southwest Pacific Islands, *Pacific Affairs,* Vol. 17, 1944, pp. 133–155; reference on p. 137.

Small coastal swamps and other poorly drained places and hilltop areas of thin soil are also left uncleared.

Plantations are laid out with the utmost nicety. Seed nuts are selected from known good trees and placed in the ground in such a position that the palm will grow straight—unlike the wild trees along the shore, which lean over the water in graceful curves. The trees are planted in a diamond pattern composed of rows of palms 25 feet or so apart. This provides rows on both the principal directions and also on the two diagonals. The resulting pattern allows 50 trees to the acre, the crowns just touching, so that all trees receive enough sunlight. The ground beneath, almost completely shaded, is later planted with a forage crop to prevent weed growth—generally either grass[3] or a native shrub called the sensitive plant, with leathery leaves that contract and curl up when touched.

Coconut palms grow rapidly and may produce a few nuts within four years. A tree is not considered mature, however, until it is seven years old, and the sustained yield of a plantation is not definitely known until it has been established for about a decade. It is difficult to estimate production, because of the insect pests and plant diseases that afflict the plantations. During early growth the palms must be weeded unremittingly. When the trees have attained a good start, the ground cover is sown. About the seventh year, when the plantation has begun to yield nearly to its maximum, cattle are brought in to graze on the cover. The cattle are not primarily a source of income, though some are regularly butchered for meat and a few hides are sold; they are to keep down the ground cover, which in its turn is keeping down the weeds. The lawnlike appearance of the plantation floor is more than mere neatness: any tall ground cover would hide the fallen nuts from the gatherers. Ordinarily one animal is needed for each acre of planting; on the more fertile Russell Island plantations, however, two to an acre are necessary. On less productive soils in other parts of the Solomons one animal for every three acres may be enough. The beef from these animals is of poor quality, though the carrying capacity of the pastures under the palms compares favorably with that of sown and irrigated fields in the cattle country of the western United States.

The heart of the plantation is the headquarters. A few hundred feet from the dock, in a garden of tropical flowers, colorful shrubs, and a few lemon and lime trees, is the planter's house. On the plantations in the Russells these houses are built on a similar plan—a few open rooms surrounded

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[3] L. T. Burcham: Livestock Grazing in the Russell Islands, *Journ. of Forestry*, Vol. 45, 1947, pp. 113-117.

by screened verandas. The house is set on posts to allow circulation of air beneath. It contains a large living room, four or more small bedrooms, and usually a bath, with a tub but no running water. The cooking is done in a small outbuilding, which may be connected with the main house by a screened runway. The native quarters are about the same on all plantations, since minimum requirements are specified in the labor laws. They are fairly small corrugated-iron huts, each providing sleeping accommodations for a dozen boys or more. Close to the beach are the work buildings: a large shed—or sheds—for copra storage, a drying building, and miscellaneous outhouses, a few of which are of native thatch construction. There is always a dock of poles and planks reaching out over the coral into water deep enough to float the plantation launch and the lighters that carry copra out to the steamer.

Plantation Operations

On established plantations activities may be classified in three groups. The first is copra making, which comprises all the operations required to pick up, bring in, and open the nuts and process, sack, store, and ship the copra. The second is maintenance—the unending fight against weeds, which, if unchecked, will overrun the plantation and cut down the yield from the palms. The third classification is a miscellaneous but special one that covers the work of cooks, houseboys, cattle tenders, boatmen, and similar "non-productive" persons. The first two classifications occupy the greater part of the plantation labor and demand little skill or training: it is on such tasks that the raw boys from the villages can be put to work under the direction of the "boss boys." The specialists require a good deal of training and are commonly old plantation hands, tried and trusted, who can understand and speak pidgin English well enough to follow directions from the "Mastah" or the "Missus." There are no seasonal differences in labor demand, and few plantations can obtain enough laborers to accomplish all the work that should be done. The Lever Brothers' plantations employ one laborer for each 10 acres during the clearing and early years of a planting; on the developed establishment the number can be reduced to one for each 25 to 35 acres. This ratio varies from plantation to plantation with the amount of weeding required and the financial condition of the planter.

A mature and healthy coconut palm drops from 200 to 300 nuts a year. Every six weeks the nuts are picked up and brought in. In the interval a single tree will shed between 6 and 40 nuts, according to the amount of wind and rain. In harvesting, another advantage of the diamond system of

planting becomes clear: the rows of trees can be worked from any one of the eight directions, and units for gathering can be readily systematized. Gangs of four or five boys are assigned to certain rows, some carrying or rolling the nuts into piles and others bagging them or loading them on a truck if motor transportation to headquarters is used. A task system of measuring work is commonly employed; the boys are paid an annual wage and are expected to perform an average of 5½ "tasks" a week. A task, therefore, amounts to a day's work. In coconut gathering it consists of filling four bags, each containing 150 pounds of green nuts.

The green nuts are piled near the drying shed for the huskers. Husking requires a little more experience than gathering. With a few sure strokes of the all-purpose tool, the copra knife, a long machete-like cleaver (Fig. 3), the fibrous husk of the nut is removed. The inner nut is split in half, the soapy milk spilled on the ground, and with a few twists of the rounded point of the knife the two halves of woody meat are gouged out and are ready for the drier.

Drying changes the green meat of the coconut to commercial copra. Three methods can be employed. Sun drying was the earliest and is still used by natives for the copra produced from wild nuts or native plantings. It removes most of the moisture but takes too long for commercial operations. The second method is to smoke the meat on racks over fires made from the coconut husks. This has the advantage of speed and requires no special equipment, but it removes less moisture than sun drying. The third method, now used on most large plantations, is kiln drying in a metal house over steampipes. This produces the best copra in the shortest time, and kiln-dried copra commonly sells for five dollars more a ton than smoked copra. Sun-dried copra was at one time nearly as valuable as kiln-dried but is now of about the same value as smoked. The finished copra is in the form of small, yellow, oily, and odoriferous lumps, which are sacked and stored to await the next call of the company steamer.

Maintenance goes on constantly, though the amount of weeding required varies greatly from one plantation to another. Russell Island planters are particularly fortunate in that the excellent soil produces a good ground cover. This is not the case on other islands, notably Guadalcanal; and as the fertility of the soil decreases after years of coconut production, more cultivation must be carried on. It is the opinion of L. F. Gill of New Georgia Island that Lever Brothers will eventually abandon their Guadalcanal holdings because of the increasing amount of cultivation necessary and will concentrate on the Russell Island plantations. A number of changes in loca-

tion of the plantations may be expected within the next few decades. Many of the present plantings are experimental in the sense that the sites were chosen without extensive knowledge of all the factors concerned. The normal life span of the coconut tree is 70 or 80 years, during which time it may produce as much as 100,000 pounds of nuts. For the last quarter of the tree's life, however, production is so low as to make replanting profitable. The large plantations in the Solomons were all established at about the same time and are now more than half through their productive period. When and if they are renewed, many of them will surely be shifted.

The third, special, kind of plantation work demands much more intelligence and experience than field operations, and, as was mentioned above, the natives who hold positions of this type are commonly ones who have served for some years on the plantation. A particularly desirable employee may be permitted to bring his wife and family, and "boss boys" receive increased wages for their increased responsibilities.

According to one authority on native labor in the Solomons,[4] household positions are not attractive to the raw boy when he first enters plantation service. The work, often meaningless to the native, is difficult to understand; and if there is a white "Missus" on the plantation, it involves the indignity of being ordered about by a woman. Natives who have had some previous contact with white people, such as those raised at mission settlements, find the domestic jobs more satisfying. The field laborers have little direct contact with the white manager. Under the Labour Regulations an employer may not strike or chastise a native employee under any circumstances—a provision bitterly resented by early planters—so that most of the plantation operations are directed by "boss boys."

Plantation Economics

The fixed investment in a plantation is comparatively small. Land rentals are nominal, and the costs of plantation buildings and machinery are a fraction of those on an American farm. The clearing and planting require considerable time, but the costs are in terms of native labor at 60 dollars a year per person, plus food, clothing, and medical attention. When once a plantation has been established, the yearly costs of supervision, native labor, and expendable materials remain relatively fixed. A reasonable estimate for annual cultivation expenses is 15 to 20 dollars an acre, according to the amount of weeding necessary.[5] The second factor in the economic pattern

[4] H. I. Hogbin: Experiments in Civilization, London, 1939, p. 162.

[5] Statement by Lieutenant A. M. Andressen, R.A.N., planter and trader on Ulawa Island.

is the yield. Planters boast of yields of half a ton of finished copra to an acre, and a reasonable expectancy for an average planting is perhaps a third of a ton to an acre. The best plantations in their prime will produce slightly more than one ton. Those of the Russell Islands are certainly of this quality.

The margin of profit, however, is only secondarily determined by the productivity of the plantation and the efficiency of its management. The most important factor is the fluctuating price of copra on the world market. A semiluxury product, copra has been subject to enormous variations in price for a commodity that can change in volume of supply only slightly from year to year. The following figures were given by Mr. Gill as the prices received on the dock in the Solomons by independent growers who disposed of their crop through traders or through a marketing organization: 1919, \$185 a ton; 1920–1929, \$100; depression years, \$6; 1939, \$23; present, \$100 (Fiji market); 1949 estimate, \$50.

Under such conditions production becomes a somewhat speculative undertaking. The large corporations are able to weather periods of low prices, especially Lever Brothers, who are also manufacturers; but independent planters find it difficult to balance profits and losses over the years, and many have sold out to the corporations. Prospective planters with small capital are discouraged from attempts to set out new plantations: "It would be inadvisable for anyone with, say, two thousand pounds to emigrate so far . . . and he would be better advised to try an older and more developed country."[6]

Effects of the War

It is still too early to judge the effects of the war on the coconut plantations of the Russells. In March of 1946, when the last American garrison was removed, the plantation personnel had not yet returned but were expected soon.[7] They will find significant changes in physical, labor, and economic conditions.

When the Japanese forces advanced southward through the Solomons in the early months of 1942, the white residents of the Russells, together with the several hundred native laborers, fled from the islands. In February, 1943, after the Japanese withdrawal from Guadalcanal, the American forces made a virtually unopposed landing on the Russells and began to develop

[6] From information supplied by the Resident Commissioner to the Colonial Office, London, 1930, and quoted in R. W. Robson: Pacific Islands Year Book, Suva, Fiji, 1944, p. 315.

[7] For information about the Russells from the end of the war until the withdrawal of the American forces and for other material the writer is indebted to Ensign Donald B. Trow, U.S.N.R., commanding officer of the last American unit to leave the islands.

the islands into an operations and supply base. A large amount of military construction followed—airstrips, camps, docks, supply dumps, warehouses, and many miles of coral-topped roads. This construction bore heavily on the plantations; for, naturally, the sites selected were on the flat land near the anchorages—the lower coastal terraces on which the plantations stood. The damage to the 12,000 acres of plantings is difficult to estimate: an airstrip with its taxiways and parking areas certainly takes 30 acres or so, and drained roadways occupy about two acres to a mile of road. It is reasonable to assume that more than 10 per cent of the palms were destroyed by military installations and usage. Many of the headquarters buildings were damaged, and the metal barracks used by the native laborers were carried away. Furthermore, a coconut plantation deteriorates rapidly if not maintained, and no cultivation has been carried on in the Russells for more than four years.

As compensation there has been a certain amount of improvement, and some of the salvage material might be utilized by the planters. A large amount of military housing is available to take the place of the metal huts. Some of it has already been purchased by Yandina Plantation for storage and housing. The docking facilities were expanded, and pontoon floats alongside which ocean-going ships can tie up were installed. There are numerous motor vehicles in various stages of deterioration that could be purchased cheaply. The great objection to all this equipment from the planter's point of view is the fact that it was intended to perform labor-saving work; the heavy construction machinery, the motor vehicles, and the roads are superfluous for planting. The coconut business is based on cheap native labor, and no operation on a plantation is mechanized unless it represents a definite saving. There is no need for the dockage in Renard Sound that accommodated a dozen heavy cargo ships at the same time, and there is certainly no reason to maintain much of it for the small steamer that calls once a month. It will hardly be worth while to keep up an airstrip against the encroachment of tropical vegetation for the occasional company visitor, who could equally well come by seaplane.

The effect of the war on labor will certainly be profound.[8] Since the establishment of the plantations there has been a gradual change in native life toward a money factor in the economy. The head tax on natives instituted by the Protectorate was a spur for them to enter plantation service. In the beginning the wages received (10 shillings a month as the statutory

[8] For an excellent review of postwar conditions over the Pacific area in general see J. W. Coulter: Impact of the War on South Sea Islands, *Geogr. Rev.*, Vol. 36, 1946, pp. 409–419.

minimum and one pound a month as the going wage) were so small as to make money precious. For a boy returning to his village, three or four pounds was a gift of importance to make to a relative or to the headman.[9] During the war there were some hundreds of thousands of American troops in the Solomons, and many of the villagers and plantation boys came into contact with them. The Americans had plenty of money, little understanding of local values, and no interest in maintaining the economic *status quo*. A cheap, hastily contrived bit of native handcraft was likely to bring as much as six or eight dollars, or whatever the native happened to ask for it—the Americans were not bargainers. It is reported that some of the natives now possess more than two thousand dollars in American currency. Unless the authorities of the Protectorate can find some way of getting this money out of circulation, plantation wages will have much less attraction than before the war. In addition, the natives have become accustomed to, or at least acquainted with, such luxuries as tinned foods, cigarettes, candy, manufactured clothing, and tools. They have seen and profited from housing facilities, medical attention, and sanitary conditions far above anything that the plantations offered or could in the future provide under the old wage scale. The white man's prestige, always one of the pillars of British colonial control, certainly will have lost some of its effectiveness.

The price of copra on the postwar market is probably of less importance to the large corporations in the Russells than to the small independent producers elsewhere in the Solomons. It would seem that there will always be a market for copra at some price, but developments in such vegetable oils as corn, cotton, and soybean might place copra in a poor competitive position. The sole economic reason for European residence in the Solomons is copra production; other exports are of minor importance, and production of some of them is concurrent with the coconut planting. The whole Pacific island area produces only about 12 per cent of the world's copra, and unless outside labor is imported, copra production in the Solomons has reached its peak. To judge from the combined totals of exports and imports since the plantations have matured (1916), there is not a large margin of profit over a long period of years. Since most of the continuing expenses are for labor and these seem certain to increase, the copra industry in the Solomons may well be squeezed out of existence between rising costs and declining demand.

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[9] Hogbin, *op. cit.*, p. 169.

UNITY AND DIVERSITY IN THE MIDDLE EAST*

W. B. FISHER

IT WAS said of a French writer who had attempted to evaluate and redefine the confused literary trends of his day that he had entered the Augean stable of French literature "pour y ajouter." A similar criticism might well be leveled at the geographer who tries to define the terms "Near" and "Middle" East, especially when the issue, after having engaged the attention of several geographical societies for some time,[1] has recently been carried to the highest governmental level.[2]

Nevertheless, it is important that the question should be resolved. The region linking Europe, Asia, and Africa is increasingly a factor in world affairs, whether regarded from the political or the economic point of view; and to the interest of specialists must now be added the awakened attention of the general public in Britain, and to a smaller extent in America, many of whom now have a firsthand acquaintance with the region as the result of military service.

"Near" or "Middle"

The older division of Asia into Near, Middle, and Far East had a certain merit of logicality, but its usefulness was impaired by the looseness with which the terms were applied[3] and by the association of "Near East" with the pre-1918 Ottoman Empire. It can be argued that there have in effect been two distinct Near Easts: the one historical, developed as the result of historical accident, a politically unified region with well-defined limits; the other geographical, smaller in extent, showing only a limited natural unity. The lack of environmental unity has made it difficult for the geographer to justify an alternative definition of a Near East when he has, rightly, shown himself unwilling to accept the Ottoman Empire as an effective geographical concept. We need only to glance at current literature to be

* A review of some of the recent literature on the Middle East of interest to geographers. The author wishes to acknowledge his indebtedness to H. A. R. Gibb, Laudian professor of Arabic at the University of Oxford, for many of the ideas that appear in this essay.

[1] See, for example, Sir George Clerk's presidential address to the Royal Geographical Society, *Geogr. Journ.*, Vol. 104, 1944, pp. 1–7, reference on pp. 4–5; also Lawrence Martin: The Miscalled Middle East, *Geogr. Rev.*, Vol. 34, 1944, pp. 335–336.

[2] Reply by the Prime Minister of Great Britain to a deputation from the Royal Geographical Society, quoted by Lord Rennell of Rodd in his presidential address to the society, *Geogr. Journ.*, Vol. 107, 1946, pp. 81–89; reference on pp. 85–86.

[3] The Middle East comprised Iran, Iraq, Afghanistan, and Arabia. To the west of this lay the Near East, to the east the Far East.

assured of the impossibility of satisfactory definitions in this respect.[4] Accordingly, main emphasis and general sanction have been given to the historical Near East; and, because of this predominantly historical connotation, the term "Near East" lost in significance with the end of the Ottomans. It may be pertinent to recall similar geographical expressions that, also having strong historical associations, have, as it were, been overlain by later political events and have taken on a restricted meaning implying fixed relation to a definite historical epoch. If we no longer speak of Eastern Rumelia, of Bosnia-Herzegovina, or of the Sanjak of Novi-Bazar, it is not because these territories no longer exist in the geographical sense but because the political conditions that helped to give them effective reality no longer obtain. It would therefore seem that there are grounds for grouping "Near East" with these historical terms, and in this way the vagueness and inaccuracy now attached to use of the expression would disappear.

The war of 1939 at one stroke removed the question of territorial definition in Western Asia from the academic groves to which it had hitherto been mainly confined. There came the *fait accompli* by which a military province stretching from Iran to Tripolitania was created and named "Middle East."

It would seem appropriate to trace the stages by which the name "Middle East" gained acceptance in its present meaning. The establishment in the region of large military supply bases brought the necessity to reorganize certain elements of both the political and the economic life of the countries concerned, in order to meet the changed conditions of war. A resident Minister of State was appointed to deal with political matters; an economic organization, the Middle East Supply Centre, originally British, but later Anglo-American, was set up to handle economic questions. It was inevitable that the territorial designation already adopted by the military authorities should continue in the new sphere; hence "Middle" East took on full official sanction and became the standard term of reference, exclusively used in the numerous government publications summarizing political events, territorial

[4] It is sufficient to consider only the geographical literature of the past few years. Sir Percy Loraine, speaking before the Royal Geographical Society, would define the Near East as the Balkan States, Egypt, and the coastal areas on the eastern shore of the Mediterranean and of the Black Sea. Colonel Lawrence Martin (*op. cit.*) would qualify this to read "and *sometimes* Egypt." On the other hand, the Middle East could be described "*roughly* as being Iran, 'Iraq, Afghanistan, and the Arabian peninsula" (Sir Percy Loraine: Perspectives of the Near East, *Geogr. Journ.*, Vol. 102, 1943, pp. 6–13, references on p. 6; italics in both cases are the present writer's). At the other end of the scale, Ernest Jurkat (see footnote 39, below) shows the Near East as extending from western Afghanistan to Crete, both inclusive, but *exclusive* of Egypt.

The inadequacy of "Near East" is also apparent from the titles "The Nearer East" of Hogarth and "Nationalism and Imperialism in the Hither East" of Kohn.

surveys, and schemes of economic development.[5] The British government was fully committed from the start to the new designation; American participation in the M.E.S.C. and other organizations has begun to bring about more slowly the same result in the other part of the English-speaking world.

Following the practice of their respective governments, a number of learned societies in both countries have adopted the new term. In Britain the Royal Institute of International Affairs and the Royal Central Asian Society employ "Middle" East without comment; in the United States a Middle East Institute has recently come into existence.[6] Equally significantly, the name has been adopted in the countries to which it is held to apply: the Jewish Agency in Jerusalem now publishes a "Statistical Handbook of Middle Eastern Countries," and the Arab Offices in London and Washington show no reluctance to follow the same usage.

With such a popular basis, it is difficult to challenge the validity of "Middle East"; and the geographer, however strongly he may feel, runs the risk of appearing pedantic when he tries to reimpose a nomenclature that has largely ceased to be current in everyday speech and association. Too much confusion now attaches to the term "Near East" for it ever to be re-adopted.

Definition of "Middle East"

How is the Middle East of the present day to be defined? The publications of the British government include 21 countries in the region—Malta, Tripolitania, Cyrenaica, Egypt, Cyprus, the Lebanon, Syria, Palestine, Transjordan, Iraq, Iran, the sheikdoms of the Persian Gulf, Saudi Arabia, the Yemen, Aden and the protectorate, Eritrea, Ethiopia, British, French, and Italian Somaliland, and the Anglo-Egyptian Sudan—but, as the author of "Middle East Science" recognizes, the inclusion of some of these is the result of fortuitous administrative grouping by military authorities. It would seem greatly preferable to omit from this list the Sudan, Eritrea, Ethiopia, and the three Somalilands, which are all more properly considered as parts of intertropical Africa, and to replace them with Turkey, which, intimately linked to its southern and eastern neighbors by ties of geography, was not

[5] Four important examples, published (1946) or to be published by His Majesty's Stationery Office, London, are the reports prepared by the members of the Scientific Advisory Mission to the Middle East Supply Centre: No. 1, "The Agricultural Development of the Middle East," by B. A. Keen (xii and 126 pp. 5s. 0d.); No. 2, "Middle East Science: A Survey of Subjects Other Than Agriculture," by E. B. Worthington (xiii and 239 pp. 7s. 6d.); No. 3, "Rural Education and Welfare in the Middle East," by H. B. Allen (vi and 24 pp. 1s. 6d.); No. 4, "Animal Industry in the Middle East," by N. C. Wright (in preparation).

[6] See the *Geographical Review*, Vol. 37, 1947, pp. 329–330.

included in the governmental publications because of a purely temporary and political separation from the rest of the Middle East.

The position of Malta and Tripolitania is open to doubt; as in the case of the Sudan, there are grounds for attaching them to other areas: and although there is little to separate Cyrenaica from Egyptian Libya, Mr. E. E. Evans-Pritchard has shown[7] that some division can be made between Cyrenaica and Tripolitania. To the west lie the Barbary States, a purely African unit; to the east, Libya and the Nile Valley, a region with affinities to Asia and, somewhat more remotely, to Southeastern Europe.

With these changes, it would seem possible to postulate on geographical grounds the existence of a natural region to which the name Middle East could be applied. It is true that the division proposed is open to criticism; but wartime experience in administration has shown that within this region there are common elements of natural environment and social organization. Our task is to discover these elements, and to evaluate them alongside the elements of disunity, which up to the present have prevented the large-scale grouping from assuming a permanent form.

Factors of Unity: Physical

As a beginning, we may note the corridor function of the Middle Eastern region, which, intimately related to the adjacent lands of Africa, Asia, and Europe, has served as a routeway by which racial and cultural movements, both autochthonous and foreign, have spread throughout the world. It is significant that the physical pattern of the Middle East combines in close juxtaposition regions of isolation, in which such movements could originate, and well-defined routeways—the Nile Valley, the Fertile Crescent, and, less apparent but none the less important, the steppe zone flanking the inner plateau basins of Asia Minor and Iran. The implications of this function of the Middle East have not been lost on the modern world. Of a number of informatory publications, best described as *ouvrages de vulgarisation,* two may be cited[8] as drawing special attention to the position of the Middle East as a factor in world affairs.

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[7] E. E. Evans-Pritchard: The Cyrenaica-Tripolitania Boundary, *Geogr. Journ.*, Vol. 107, 1946, pp. 169–170.

[8] The Middle East: Turkey-Syria-Palestine-Transjordan-Egypt. 38 pp. *Royal Inst. of Internatl. Affairs Information Notes No. 1,* 1943. 6d.

The Middle East: Australia's Front Line. 36 pp. *World Affairs Paper No. 3.* Research Section, Australian Institute of International Affairs, Melbourne, 1941. 5d.

To these may be added Samuel Van Valkenburg: Whose Promised Lands? [A Political Atlas of the Middle East and India], *Headline Ser. No. 57,* Foreign Policy Association, New York, 1946, pp. 5–88.—Edit. Note.

Perhaps the greatest single physical factor of unity in the Middle East is climate. A marked seasonal rhythm of rainy winters and dry summers —with summer aridity absolute south of a line from the Elburz Mountains to Crete—and a temperature range best described as moderately continental produce highly characteristic conditions. To this simple regime there are only two significant exceptions. On the eastern Black Sea coast of Asia Minor and near the southern shore of the Caspian a summer maximum of rainfall indicates an approach to conditions of continental interiors in temperate latitudes; in the uplands of southwestern Arabia a monsoonal current, still something of a mystery in its origin and behavior, brings summer rainfall to the Yemen but not to the coastlands of Aden.

Climatological studies of the Middle East are few, and so far no general synthesis of climate has appeared. One obstacle is the lack of data, but the recent war has partly improved the position, and further development in this field is now probable. Within the last few years three publications of the Section Géologique de la Délégation Générale Française au Levant[9] have made a small beginning on the general problems of climate and meteorology in the Middle East. On the "Carte pluviométrique" the limitations of the data are clearly apparent, and the short period of the rainfall averages, in a region where variability of rainfall is pronounced, detracts somewhat from the value of the results.

Another aspect of climate in the Middle East, the possibility of climatic change within historical time, has been dealt with in two very dissimilar works:[10] Keen's "The Agricultural Development of the Middle East" and Glueck's "The River Jordan." From both books emerges an emphatic verdict that such changes as have appeared are due to man's activities, and not to climatic variation. Mention will be made of the first work at a later stage; Dr. Glueck's study, primarily archeological and historical, embodies much sound observation and valuable research, but it is vitiated by overstatement and an unfortunate choice of language. The illustrations, among the finest ever to appear in a study of the Middle East, also lose from inadequate reproduction.

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[9] C. Combier: Aperçu sur les climats de la Syrie et du Liban, une carte au millionième des pluies et vents. 31 pp. Beirut, 1945.

W. B. Fish [i.e. Fisher] and L. Dubertret: Carte pluviométrique du Moyen-Orient au deux millionième, *Notes et Mémoires de la Section Géol.,* Vol. 4, 1946, pp. 115–121.

W. B. Fish [i.e. Fisher]: Premiéres notes sur la météorologie de la Syrie et du Liban, *ibid.,* 1945, pp. 91–113.

See also L. Dubertret: Présentation de cartes géologiques et topographiques de la Syrie et du Liban, *Bull. L'Assn. de Géographes Français,* Nos. 181–182, 1946, pp. 114–115.

[10] Keen, *op. cit.* (Footnote 10 is continued on the following page.)

Occupations and Social Groupings

Vegetation, both natural and cultivated, shows close adaptation to the climatic regime. A rapid cycle of growth and structural adaptation to resist water loss or special tolerance of aridity and salinity give rise to a flora that, although varying locally, imposes a markedly uniform pattern throughout the region as a whole. More important still, man's organization of this environment is conditioned by a scarcity of water (irrigation is necessary for certain crops even on the west coast of Syria, where rainfall is more than 35 inches a year). This conditioning has produced a closely linked trilogy of occupations and social groups. The most important element in the trilogy is the agricultural population of the Middle East. In a brilliant study[11] the late Dr. Jacques Weulersse insists on the essential unity of this peasant group, which, sharing a common tradition of specialized occupation of the soil, extends far beyond the limits of political frontiers. One of the factors of peasant unity is the long period of occupation, from which arises a distinguishing quality: "Le fellah est tout le contraire d'un primitif; ce serait plutôt un hypercivilisé." Peasant life must therefore be related to a dual background of history and geography, and with this approach, fully expanded by detailed regional observation of the highest order, Dr. Weulersse propounds the thesis that material and social conditions are interrelated and that changes in the one will inevitably affect the other—a thesis of the greatest importance to the relationship between the Middle East and the Western powers.

Alongside the cultivating population are the nomads—pastoral, yet dependent on the settled people they despise for a part of their food supply, especially when rains have failed in the desert. Also in close relation are the town dwellers, the merchants and small craftsmen, often hated by the peasants as middlemen and extortioners, who nevertheless provide an outlet for agricultural produce and who supply in return a small quantity of manu-

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Nelson Glueck: The River Jordan: Being an Illustrated Account of Earth's Most Storied River. xvi and 268 pp. The Westminster Press, Philadelphia, 1946. $3.50.

A background to Biblical studies is provided by George Ernest Wright and Floyd Vivian Filson (editors) in "The Westminster Historical Atlas to the Bible" (114 pp. [Westminster Aids to the Study of the Scriptures.] The Westminster Press, Philadelphia, 1945. $3.50 [English edition, S.C.M. Press, London, 1946. 21s.]). In addition to numerous maps showing physical features and political grouping at various periods, there is an outline of the wider historical and cultural movements in the Middle East and the Mediterranean. "The Westminster Dictionary of the Bible," edited by John D. Davis, is another useful reference book (5th edit., revised and rewritten by Henry Snyder Gehman. xii, 658, and 4 pp. *Ibid.* The Westminster Press, Philadelphia, 1944. $3.50).

[11] Jacques Weulersse: Paysans de Syrie et du Proche-Orient. 329 pp. (Le Paysan et la Terre, No. 3.) N.R.F.-Gallimard, [Tours], 1946. 360 fr.

factured goods. From these three elements, closely integrated by material and cultural ties, has arisen the present complex pattern of society in the Middle East; and it is on this basis that one can postulate a unity for the region as a whole. As a tapestry or painting owes its special character to an intermingling of diverse color masses, so the Middle East can be conceived as a unity based on a number of distinctive yet related ways of life. It is also possible to discern why a more restricted territorial definition such as "Near East" is difficult of application. Trade, agriculture, and nomadic pastoralism in close connection are as characteristic of Iran as of Egypt or Arabia; and the attempt to divide the Levant from Iraq ignores the presence of the Syrian desert, a region that gives a measure of unity to the lands on its borders, in much the same way as the countries of Southern Europe are linked by the Mediterranean.

Complementing the material factors of unity is the more easily apparent cultural influence of Islam, which, like Judaism, is a strong social bond. Although non-Moslem minorities exist and schism has created a Shi'a block within the Sunni world, the influence of a single religious system, based on easily understood principles, has given rise to a culture that now transcends purely religious limits. No one would dispute the validity of the expression "Moslem world," though this cannot be defined in terms of race, of language, or of political grouping.[12]

At the present time cultural patterns, developed on a basis of Moslem civilization, are evolving along new paths. It is probable that Islam as a religion is in decline—the complaint of slackness in observance and nonattendance at prayers would, however, find echo in contemporary Christian clerical circles—and that materialism and nationalism borrowed from the West are tending to replace older values. Two important books illustrate this tendency.[13] In A. H. Hourani's "Syria and Lebanon" we have as it were the mechanism of the change: Moslem society driven by the pressure of events to adopt new ideas and new techniques from outside in order to survive in a world dominated by alien influences. "Reaction to the impact of the West has been neither uncritical rejection nor uncritical acceptance, but a process of questioning which still continues." Freya Stark's "East

[12] Cf. Edward J. Byng: The World of the Arabs (xx and 325 pp. Little, Brown & Co., Boston, 1944. $2.50) for a discussion of these points.

[13] A. H. Hourani: Syria and Lebanon: A Political Essay. x and 402 pp. Issued under the auspices of the Royal Institute of International Affairs. Oxford University Press, London, New York, Toronto, 1946. $5.00. Reference on p. 74.

Freya Stark: East Is West. xxii and 218 pp. John Murray, London, 1945. 12s. 6d. (American edition: The Arab Island: The Middle East, 1939–1943. xxiv and 235 pp. Alfred A. Knopf, New York, 1945. $3.50.)

Is West" gives us results of the penetration of Western ideas. The older society of Ottoman days is giving way to a new grouping, in which the aristocratic "pasha" is replaced by a middle-class "effendi" more closely attached to the people for whom he is working, either as administrator or as technician.

Nationalism is in some respects a tendency running counter to unity. Nevertheless, there are signs that the wider implications of Middle Eastern unity are not forgotten, and that a more comprehensive political grouping, for which there is abundant historical sanction, may one day develop. In 1944 the Arab League, comprising the states of Egypt, Iraq, the Lebanon, Saudi Arabia, Syria, Transjordan, and the Yemen, came into existence.[14] As at present constituted, the Arab League represents merely a negative attitude, a defensive reaction in the face of outside aggression. Concerned only with the limited objective of joint political action in order to preserve or develop the autonomy of Moslem regions, the league must be thought of merely as a tactical union of convenience, since any attempt at joint economic development of the member states has so far been avoided.[15] This is not to say, however, that the future policy of the Arab League must always remain negative:[16] sharing a common experience of recent penetration or domination by Western powers, all the states of the Middle East have a single political objective that may well be the basis of a more substantial cooperation at a later period. Signs are not lacking that the Arab League may one day be expanded to include the non-Arab states of Turkey and Iran,[17] both of which form part of the Moslem world and have in different ages made effective contributions to the organization of the Middle East as a single unit.

Factors of Diversity: Landforms and Structure

Among the outstanding factors of diversity must be reckoned landforms and structure. In the north, there extends a broad belt of folded ranges,

[14] On the evolution of the Arab League see Cecil A. Hourani: The Arab League in Perspective, *Middle East Journ.*, Vol. 1, 1947, pp. 125–136.

[15] The establishment in London and Washington of Arab Offices, from which propagandist material is issued, is interesting as a sample of the activities of the Arab League and as an illustration of the manner in which the Arab has taken up the weapons of the West in order to resist Western pressure.

[16] "The duty laid upon the Arab leaders is, in its essence, closely parallel to that laid upon the leaders of the United Nations. In their respective spheres both must stimulate and mobilize the moral forces which will transform a negative and defensive union into a creative enterprise" (H. A. R. Gibb: Toward Arab Unity, *Foreign Affairs*, Vol. 24, 1945–1946, pp. 119–129; reference on p. 129).

[17] In this connection, one may note the conclusion of a Treaty of Friendship between Turkey and Iraq in April, 1946, and of a Pact of Friendship between Turkey and Transjordan, signed in January, 1947. In the early part of 1946 the President of the Lebanese Republic paid an official "visit of friendship" to Turkey.

enclosing fragments of older structures, some of which, such as the plateau block of central Iran, are large and some, such as those of Turkey, are small though numerous. The intense disturbance of the region, which cannot yet be said to have come entirely to an end, has given rise to widely different structural formations. In Armenia, immense lava flows of Tertiary and Quaternary age border forms of Archean origin; and the simplicity of folding in the western Zagros contrasts strongly with extensive overthrusting and deformation in the inner parts of the ranges. A full range of rock types, from Archean gneiss and Cambrian rock salt to Quaternary sandstone, adds further variety to the region.

Outside the geosynclinal area of the north, the Middle East consists of a vast stable block, on which sediments have been laid down in discontinuous horizontal layers. This block, part of the ancient continent of Gondwanaland, has undergone fracture in the Red Sea–Jordan–Orontes area, with the result that Arabia is now detached from the main African mass; but otherwise the block has resisted fold movements, so that later sediments resting on it are either undisturbed or merely wrinkled. Broad, open landscapes, extensive river basins, and rolling plateau country are therefore characteristic of the center and south.

Complexity of structure and inaccessibility have retarded geological exploration, and many fundamental problems remain to be solved. In the last few years, however, important advances have been made. A full geological map of Turkey, excellently produced in eight sheets, has recently been completed and contributes greatly to an understanding of one of the most involved of geological regions.[18] Mention must also be made of the work of Dr. L. Dubertret in Syria and the Lebanon. The pre-1918 surveys of Blanckenhorn have been extended and developed to cover most of the two countries, and the results of twenty years of devoted work, at times singlehanded, appear in a series of maps now in course of publication.[19] From these maps one can appreciate not only the physical structure of the northern Levant but also the interrelation between physical conditions and social development through which a mixed population of Moslems and Christians, living side by side for centuries, have come to be in close occupation of a topographically difficult region. Reference may also be made to the work of Leo Picard of the Hebrew University of Jerusalem, notably "Structure and

[18] Geological Map of Turkey. 1 : 800,000. In 8 sheets. Ministry of the Interior, Ankara, 1946.

[19] Section Géologique, Délégation Générale de France au Levant, Beirut: Carte lithologique de la bordure orientale de la Méditerranée (with notes in French and English), 1943; Carte géologique de la Syrie et du Liban au 200.000^{me} (in preparation); Carte géologique de la Syrie et du Liban au 50.000^{me} (in preparation). See reference in footnote 9.

Evolution of Palestine."[20] Professor Picard has greatly advanced our knowledge of the tectonics of the Levant, particularly in relation to the difficult question of the formation of the Red Sea–Jordan rift.

In 1940 the American geologist F. G. Clapp published a most important study of eastern Iran,[21] an area thitherto practically untouched by geological surveys. New light has been thrown on a part of the Middle East that by reason of structural complexity and difficulty of access—both topographically and politically—had remained largely unsurveyed. A later work by Dr. R. Furon of the University of Teheran[22] summarizes much of the existing geological literature on Iran and provides a copious bibliography. Dr. Furon also discusses the possibility of a continuation of the Ural fold system into central Iran, and a prolongation even as far as Oman and Madagascar. In this, as also in a geological map accompanying the article, he has been subjected to some criticism from other authorities on the geology of Iran. A further study of the region, more particularly the structural and tectonic aspects, has been made by J. W. Schroeder.[23]

Racial, Linguistic, and Religious Diversities

The racial, linguistic, and religious divisions of the Middle East, outstanding among factors of disunity, cannot easily be summarized, because of their extraordinary diversity. The Middle East, a land bridge, has received racial contributions from many parts of the Old World. Some have been assimilated and intermingled with previously existing strains; others have drifted into isolated areas—mountain or desert—and have thus maintained a relative purity. The Armenians and the Syrian Bedouins, the one a highly distinctive branch of the Alpine race, the other of comparatively unaltered Mediterranean stock, might be taken as typical of the latter group; in the more open lands a basic Armenoid and Mediterranean intermixture has been enriched by Hamitic, Negrito, Mongoloid, and proto-Nordic elements in varying proportion.

Language distribution is easier to define. Within the last twelve centuries Arabic, a Semitic tongue from central Arabia, has almost entirely ousted all other languages in the southern part of the Middle East, and Aramaic,

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[20] Leo Picard: Structure and Evolution of Palestine, With Comparative Notes on Neighbouring Countries. iv and 134 pp. *Bull. Geol. Dept., Hebrew Univ., Jerusalem*, Vol. 4, No. 2–3–4, 1943.

[21] Frederick G. Clapp: Geology of Eastern Iran, *Bull. Geol. Soc. of America*, Vol. 51, Part 1, 1940, pp. 1–101.

[22] Raymond Furon: La géologie du plateau iranien (Perse-Afghanistan-Béloutchistan), *Mémoires Musée Natl. d'Hist. Naturelle*, Vol. 7 (N.S.), No. 2, Paris, 1941, pp. 177–414.

[23] Jean William Schroeder: Essai sur la structure de l'Iran, *Eclogae Geol. Helvetiae*, Vol. 37, No. 1, 1944, pp. 37–81.

an older Semitic language that was widely spoken in the time of Christ, now survives only in a few villages near Damascus and Mosul. The flood of Arabic was arrested at the mountain zone of the north; and Persian, although much influenced by Arabic, is still current in the extreme east. Eastern Anatolia is a veritable museum of languages. Kurdish and Armenian are the most widespread, but numerous Caucasian and Central Asiatic languages are spoken by tribesmen. Farther to the west, Turkish, also from Central Asia, has established a dominance over Greek, which now survives only in Cyprus and the smaller islands. Later intermingling of peoples on a small scale has made it necessary for most modern governments to employ at least two, and sometimes three or four, official languages.

Although predominantly Moslem, the Middle East contains minorities of Christians and Hebrews, whose frequently higher economic and cultural level gives them an influence out of proportion to their numbers. Some of these minorities have connections with larger communities in Europe and America; others are isolated remnants of early Christian sects that have died out elsewhere.

Islam itself is by no means united. The Shi'a faith is dominant in Iran and in much of Iraq and may be considered a reflection of the separate cultural development of that area, which owes somewhat more than the rest of the Middle East to classical Greek influence. Farther west, smaller sects have found relative security in highland areas from orthodox Moslem persecution. The Yazidi of the Jabal Sinjar of Iraq and the Alawi, Druses, and Metwali of western Syria all represent heretical Moslem belief combined with a more primitive animism and totemism. The Alawi have been studied by Weulersse,[24] and once again a valuable piece of local documentation shows one line along which future research must move; especially interesting are his numerous local distribution maps, usually rare in studies of the Middle East.

Growth of Nationalism

Upon such a variegated social basis, the present national states have been built; and it is inevitable that many communities should find in the existing frontiers an incomplete realization of their political aspirations. Chief among these nationally conscious groups are the Kurds, the Armenians, and the Assyrians; and of these the Kurds, living in the mountain zone of the borders of Turkey, Syria, Iraq, and Iran, are the largest in number. A realistic survey

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[24] Jacques Weulersse: Le pays des Alaouites. Vol. 1, 418 pp.; Vol. 2, 104 plates. (Institut Français de Damas.) Arrault & cie, Tours, 1940. 250 fr.

by Westermann[25] traces the political and social development of all three groups and relates local feeling to wider questions of international rivalry involving Britain, France, Russia, and the United States. The survey is authoritative and carefully documented, but at times an obscurity of language makes it difficult to separate fact and deduction from a background of suggestion and imputation deriving from political intrigue—a situation that in one sense, however, may be considered an epitome of Middle Eastern politics as a whole. The author's conclusion that no wholly acceptable solution of present difficulties is likely to be found will immediately invite a comparison with the position in Palestine.

The social organization of the Kurds has been described at greater length by Professor Westermann and by W. G. Elphinston.[26] Tribalism still persists; and a marked individualism, which has hitherto prevented the development of political cooperation, together with the scattered distribution of the Kurds makes it difficult to see how a successful national unity could emerge.

The recent development of nationalist states in the Middle East has in some respects been a further factor of disunity. Member states of the Arab League, at various levels of economic and political evolution, have so far shown somewhat of a disinclination to extend political cooperation into the economic field. Economic nationalism, a feature during the last 20 years of Turkey and Iran, and to a smaller extent of Egypt, has tended to emphasize the differences between states. Egypt, deriving advantage from a position on the main trade routes of the world, is drawing farther and farther away from countries such as Transjordan, where natural resources are few; and the establishment of cotton mills by strongly nationalist rulers in Turkey and Iran has acted unfavorably on the older textile centers of Syria, which formerly could count on the entire Ottoman Empire as a market. How far these difficulties will disappear under the solvent of political cooperation remains to be seen.

A thoughtful interpretation by Haas[27] deals with the growth of nationalism in Iran, where special features deriving from the relative isolation of the country have given rise to a highly individual culture. A philosophic conception dominates the work: emphasis is placed on things of the mind as

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[25] William Linn Westermann: Peoples of the Near East without a National Future. 20 pp. (American Interests in the War and the Peace.) Council on Foreign Relations, New York, 1944.

[26] William Linn Westermann: Kurdish Independence and Russian Expansion, *Foreign Affairs,* Vol. 24, 1945–1946, pp. 675–686.

W. G. Elphinston: The Kurdish Question, *Internatl. Affairs,* Vol. 22, 1946, pp. 91–103.

[27] William S. Haas: Iran. xi and 273 pp. Columbia University Press, New York, 1946. $3.50.

a key to an understanding of the modern country; and this unusual approach, which devotes a chapter to Persian psychology but relegates irrigation to a short appendix, permits the close synthesis of geographical and historical fact that would seem to be the best method of understanding the Middle East and its inhabitants.

Two useful little works concerned with factual presentation give the salient features of the development of Transjordan.[28] Transjordan, in certain respects an artificial unit, would benefit from a wider political grouping that would place it more closely in touch with the Mediterranean and with neighboring areas of the Levant. The historical role of Syria, a debatable ground between East and West, is given prominence in Mr. Fedden's "Syria,"[29] which, based on intimate acquaintance with virtually all parts of the country, claims to be the first comprehensive survey in English of Syria and its peoples. Colonel de Gaury vividly depicts Arabian life under the patriarchal government of King ibn-Saud.[30] Recent exploitation of oil by American interests, in a country hitherto isolated from the rest of the world, has produced a sudden impact of Westernization; and one of the most interesting parts of "Arabia Phœnix" deals with the social and physical changes among former nomads who are now working in the oil fields. The influence of the Western world on Saudi Arabia is also treated by K. S. Twitchell.[31]

Problems of the Middle East

In a masterly summary by Professor Gibb[32] the main problems of the Middle East at the present day are said to lie "in unregulated or badly regulated economic institutions, in insufficient power of control on the one hand and maladjustment of production and distribution on the other, in the general failure of the local Governments to understand the problems in-

[28] A. Konikoff: Transjordan: An Economic Survey. 2nd edit. 120 pp. (and Supplement, "Selected Bibliography of Eastern Palestine," 16 pp.). Jewish Agency for Palestine, Economic Research Institute, Jerusalem, 1946. 600 mils.

Baha Uddin Toukan: A Short History of Trans-Jordan. 49 pp. Luzac & Co., London, 1945. 5s. (paper cover).

[29] Robin Fedden: Syria: An Historical Appreciation. 288 pp. Robert Hale & Co., London, 1946. 21s.

[30] Gerald de Gaury: Arabia Phœnix: An Account of a Visit to Ibn Saud, Chieftain of the Austere Wahhabis and Powerful Arabian King. 169 pp. George G. Harrap & Co., London, Sydney, etc., 1946. 10s. 6d.

[31] K. S. Twitchell, with the collaboration of Edward J. Jurji: Saudi Arabia; With an Account of the Development of Its Natural Resources. xiii and 192 pp. Princeton University Press, Princeton, N. J., 1947. $2.50 (See the review in the *Geogr. Rev.*, Vol. 37, 1947, pp. 337–338.) See also Richard H. Sanger: Ibn Saud's Program for Arabia, *Middle East Journ.*, Vol. 1, 1947, pp. 180–190.

[32] H. A. R. Gibb: Middle Eastern Perplexities, *Internatl. Affairs*, Vol. 20, 1944, pp. 458–472; reference on p. 458.

volved, . . . their selfishness and their general fumbling." Bitter wartime experience of inflation, high prices, and shortage of necessities not only has emphasized the importance of economic factors but has brought into question the whole system of government, which in many instances has shown itself unequal to coping with the situations produced.

At a time when such questions have come to the forefront, it is useful to have a number of objective analyses of economic development in the Middle East. The "Statistical Handbook" of the Jewish Agency for Palestine has rendered valuable service in summarizing in a single volume the more important material available for Middle Eastern countries.[33] The statistics range from climatic and population data to cost-of-living indices, but they must be viewed against the background of local conditions—a high degree of illiteracy among the general population, widespread distrust of the intentions of official enumerators, and "a mentality which does not always view with favour the exact and numerical approach to reality."

The title of Alfred Bonné's "The Economic Development of the Middle East"[34] is to some extent misleading; for the book tends to devote its attention to the problems of Palestine in relation to those of other Middle Eastern countries, and the section dealing with "the peculiar position of Palestine as the country of the Jewish National Home" and Palestine's "potential importance for other Oriental countries," gives only one of a number of possible solutions to economic difficulties in the Middle East.

One of the more valuable parts of Worthington's "Middle East Science"[35] is a statement of the position in the Middle East of various branches of applied science. The complexity of the problems in general and the interdependence of physical and social factors are again made plain, but at the same time the author draws attention to specific ways in which future development might take place. As an example of a reasoned scientific approach to problems that under Middle Eastern conditions are too often seen only

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[33] Statistical Handbook of Middle Eastern Countries: Palestine, Cyprus, Egypt, Iraq, the Lebanon, Syria, Transjordan, Turkey. 2nd edit. x and 183 pp. Jewish Agency for Palestine, Economic Research Institute, Jerusalem, 1945. 800 mils. Reference on p. III.

For further statistical details on Palestine see the *Statistical Abstract of Palestine, 1944–1945*. 8th edit. x and 295 pp. Compiled and published by the Department of Statistics, Jerusalem, 1946. 800 mils or 16s. od. (Crown Agents for the Colonies, London). This edition for the first time includes "a chapter on Physiography, which describes the development of meteorological observations, and the climatic conditions in Palestine, and a chapter on the Census of Industry of 1940 and of 1943."

[34] Alfred Bonné: The Economic Development of the Middle East: An Outline of Planned Reconstruction after the War. Revised edit. xii and 164 pp. (International Library of Sociology and Social Reconstruction.) Kegan Paul, Trench, Trubner & Co., London, 1945 (first published in Jerusalem, 1943). 12s. 6d.

[35] See footnote 5, above.

in their political aspect, "Middle East Science" is an important contribution.

Similar observations can be made of Keen's book on Middle East agriculture.[36] Agriculture supports by far the greater part of the population, and most schemes for development come back to the fundamental problem of increasing the productivity of the land. In Dr. Keen's opinion the Middle East stands on the verge of a rapid agricultural evolution similar to that which took place one or two centuries ago in Western Europe. It is necessary, however, once again to guard against a too hasty adaptation of Western methods: the centuries-old swing plow, ideally suited to a shallow soil underlain by hardpan, cannot even yet be satisfactorily replaced by a steel implement; and the practice of burning animal dung for fuel, long condemned by Western agriculturists, is shown by Dr. Keen to be at least as useful as letting manure become oxidized in the top layer of soil that may reach a temperature of 160°–180° F. in the summer. The need for a general approach to agricultural problems is also stressed, the whole emphasis of the study being laid on the similarity of physical and social conditions over a wide area.

Of the great need for education there is little to say here,[37] but it is important that instruction should be carefully adapted to the real needs of the population. The growth of a "young effendi" class comparable with the babu of India should be avoided at all costs, and there is danger in a too rapid spread of Westernization in this respect. In the words of Professor Gibb, "what is wrong with the present Western institutions in the Middle East is . . . that they are too superficial, having no depth of foundation in the minds of either politicians or people."

Summing the main economic problems of the Middle East, Dr. K. A. H. Murray[38] draws attention to the fact that too optimistic a view is sometimes taken of the potentialities of the region. Only 5 per cent of the total area is regarded as cultivable, and the mineral resources are small; hence there is inevitably a low standard of productivity, which is further depressed by the prevalence of disease. By its short but incisive and well-informed examination of current problems, Dr. Murray's article acts as a valuable corrective to a number of somewhat inflated estimates of economic productivity that have recently appeared.

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[36] See footnote 5. Attention may also be called to the many valuable papers published in the *Proceedings of the Conference on Middle East Agricultural Development, Cairo, February 7–10, 1944* (x and 220 pp. *Middle East Supply Centre Agric. Rept. No. 6,* Cairo. 25 pt.).

[37] See Allen, *op. cit.* (see footnote 5).

[38] A short outline is given in: Keith A. H. Murray: Some Regional Economic Problems of the Middle East, *Internatl. Affairs,* Vol. 23, 1947, pp. 11–19.

POPULATION PRESSURE

One of the outstanding economic problems of the present-day Middle East is pressure of population. A timely series of monographs[39] draws attention to the rapid growth in numbers, which in Turkey is expected to produce a 70 per cent increase between 1935 and 1970. Lack of data makes it difficult to carry demographic analysis very far, but it is apparent that for the Middle East as a whole birth rates of 50 to 60 per thousand must be considered average. High death rates have hitherto acted as a check, but experience in India has shown that advances in social conditions tend to reduce the death rate, without effecting a corresponding decrease in births, so that unless the general productivity of land is increased, the general standard of living is threatened. The problem is accentuated in Egypt, where 99 per cent of the population of 16.5 million are living on the 4 per cent of the total area contained in the Nile valley and delta. With limited prospects of extension of the cultivated land, and with only a slender basis for industrialization, Egypt does not face an encouraging outlook. Better health measures to reduce the alarmingly high incidence of disease seem doomed to react unfavorably at first on the general standard of living.

In Turkey, Iran, Iraq, and the Levant prospects appear somewhat better. An improved technique of agriculture and wider development of irrigation could extend the margin of cultivation considerably. Moreover, the varied mineral wealth, particularly in Turkey and Iran, offers potentialities for a relatively substantial measure of industrialization; and in the Levant commerce based on transit traffic, light industry, and a tourist-pilgrim traffic could help to support a larger population.

In the past, emigration, chiefly to the Americas, and best developed in the Levant, has absorbed a surplus of population. This movement is now falling off; and Cleland suggests that a solution to the general population difficulties of the Middle East might lie in controlled migration within the region itself. Previous experience with the Armenians in Syria and the Assyrians in Iraq has not been happy, but increased irrigation in Iraq might make it possible to settle a part of the excess population of Egypt there.

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39 Ernest Jurkat: Prospects for Population Growth in the Near East, *in* Demographic Studies of Selected Areas of Rapid Growth, *22nd Ann. Conference Milbank Memorial Fund, 1944*, New York, 1944, pp. 79–96.

Clyde V. Kiser: The Demographic Position of Egypt, *ibid.*, pp. 97–122.

W. Wendell Cleland: A Population Plan for Egypt, *ibid.*, pp. 123–137.

Frank W. Notestein and Ernest Jurkat: Population Problems of Palestine, *Milbank Memorial Fund Quart.*, Vol. 23, 1945, pp. 307–352.

Eliahu Epstein: Demographic Problems of the Lebanon, *Journ. Royal Central Asian Soc.*, Vol. 33, 1946, pp. 150–154.

In discussing the demographic position of Palestine, it is difficult, or perhaps impossible, to separate economic from political factors. A careful survey based on statistics that are more comprehensive than for most Middle Eastern countries states conclusions that would well repay study by anyone interested in the future of Palestine:

> The needed economic development may be possible; it can scarcely be profitable . . . Clearly, therefore, all parties in the region have a stake in the maintenance of Jewish interest . . .
>
> On the other hand, . . . it appears that a catastrophe . . . is not outside the bounds of possibility if enthusiasm for a Jewish state should result in . . . really heavy immigration . . . There are almost no limits to the population that could be supported, given someone to bear the cost. There are very real limits to the population that has any prospect of being self-supporting at reasonable levels of living . . . The higher the density, the greater the difficulties and the greater the cost. . . . If heavy immigration should come about soon, there is even a considerable chance that the whole process will break down and that within a decade or two there will be an emigration of Jewish population.[40]

The Oil Resources

A further factor in the economic development of the Middle East is the utilization of the oil resources, which would now seem to be among the most extensive in the world. A short but useful summary by G. M. Lees[41] adds considerably to our knowledge of a question that, because of the international rivalries centering about it, has so far been little discussed factually. Pipe lines, in operation and construction, from Iraq and the Persian Gulf to the Mediterranean are enabling states of the Levant to share in benefits accruing to the actual oil zones in Iran, Iraq, and Saudi Arabia; and there is slowly taking shape an increasingly close economic integration affecting the Iranian and Saudi Arabian nomads now employed in the oil fields, the cultivators of Iraq, where royalties are being spent on irrigation development, and the commercial populations of Haifa and Tripoli. The joint participation of Western powers in the exploitation of oil resources—the Iraq Petroleum Company type of arrangement between Britain, France, and the United States and the recent Anglo-Iranian Oil Company agreement with American interests may be cited—gives hope that friction over oil concessions may be avoided, though the position of Russia remains doubtful. Oil resources in more specific relation to their geographical setting are

[40] Notestein and Jurkat, *op. cit.* (see footnote 39), pp. 349–351.

[41] G. M. Lees: Oil in the Middle East, *Journ. Royal Central Asian Soc.*, Vol. 33, 1946, pp. 47–57. Reference must also be made to G. M. Lees and F. D. S. Richardson: The Geology of the Oil-Field Belt of S.W. Iran and Iraq, *Geol. Mag.*, Vol. 77, 1940, pp. 227–252, which gives an authoritative and highly informative description of one of the largest oil structures in the world.

dealt with in a longer article by Dr. Lees, which will form a chapter in the book on the world geography of petroleum now in preparation at the American Geographical Society.

Political Problems

Attention must be given first to internal affairs; for at the present time a crisis of unusual severity and extent is bringing into question the entire spiritual and political bases of society. The weakness of the Islamic world vis-à-vis the West has led to much self-criticism among Moslems themselves. Has Islam failed? Should there be a return to Islam, with a corresponding rejection of Western ideals? How far is it possible to combine the best of both systems, so as to produce a new social philosophy? Such questions are consciously or unconsciously in the minds of many of the more progressive elements in the Middle East; and the apparent success of the materialist nationalism of Europe and America, which is constantly before them, induces a temptation to follow a similar path.

The widespread lack of enlightened political leadership has led to a general mood of impatience and frustration that could easily foster dictatorship. "Strong" methods have a certain appeal to Middle Eastern peoples as frequently the only way by which direct action can occur in a stagnant political system—we need only note the regimes of Kemal Atatürk and Riza Shah in this respect[42]— but such action is at the price of the severance of a country from its neighbors and the ultimate narrowing of social and political opportunity. "Dictatorship in petty States is a factor of disintegration and conflict."[43]

One approach to the problem would seem to lie in a closer and more positive mutual understanding of the cultures of East and West. This point is emphasized by the authors cited as dealing with general philosophical questions,[44] and it is significant that Mr. Hourani, as a representative of the East, should feel that "Islam will be helped in defining its attitude to philosophical issues by considering the attitude taken by another religion." There is, however, much need for greater discrimination and selection in the acceptance of the cultural contributions made by the West to the life of the East, in order to avoid a perfunctory imitation of the West without an understanding of the deeper principles involved.

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[42] It might also be suggested that the enthusiastic applause accorded by Middle Eastern cinema audiences to newsreel shots of Generalissimo Stalin—far greater than for any other war leader—derives in part from the same psychology.

[43] Gibb, Middle Eastern Perplexities (see footnote 32, above), p. 462.

[44] *Ibid.*, A. H. Hourani, *op. cit.* (see footnote 13, above), and Stark, *op. cit.* (see footnote 13).

In the sphere of external politics, attention has centered on two main problems: the maintenance or attainment of full independence; and a final settlement of the Palestine question. The withdrawal of the British from Egypt and the French from Syria has brought the first aspiration considerably nearer to full realization; the second remains, a focus of cultural, economic, and political rivalry, involving a growing circle of states and communities.

The Palestine Problem

There can be no general discussion of Palestine within the limits of the present essay, It is, however, urged that there be more of geography and less of politics in our approach to the problem. Greater attention could well be given not merely to the physical factors affecting absorptive capacity for immigrants and possible economic development but also the wider aspects of geography, involving adjacent countries. Palestine cannot be considered in isolation from its neighbors; the underlying theme of several books reviewed here is that the interests and problems of any one country in the Middle East transcend its boundaries and that changes in one area will ultimately cause repercussions in another.

This fact is implicit in a number of studies devoted to possible economic development in Palestine and the Middle East as a whole, including the report of the Anglo-American Committee of Inquiry. This report, which provides a most important summary not merely of political events but also of economic development and future possibilities, states that the full development of irrigation "requires the willing cooperation of adjacent Arab states."[45] Under present political conditions in the Middle East this cooperation is, to say the least, unlikely; nevertheless, a number of schemes for the development of irrigation have been proposed, most of which require collaboration from Syria, the Lebanon, and Transjordan. The best known of these schemes is that of Professor Lowdermilk,[46] who advocates large-scale development of the water resources of the Jordan Valley in a manner somewhat similar to that followed by the Tennessee Valley Authority. Other plans involving the utilization of water resources lying in part outside

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[45] Anglo-American Committee of Inquiry: Report to the United States Government and His Majesty's Government in the United Kingdom, Lausanne, Switzerland, April 20, 1946. viii and 92 pp. *U. S. Dept. of State Publ. 2536* (*Near Eastern Ser. 2*), 1946. Reference on p. 10. See also: "A Survey of Palestine, Prepared in December 1945 and January 1946 for the Information of the Anglo-American Committee of Inquiry." Vol. 1, vi and 534 pp.; Vol. 2, v and 535–1139 pp. Government Printer, Palestine, 1946. £P.2 per set.

[46] Walter Clay Lowdermilk: Palestine: Land of Promise. xi and 236 pp. Harper & Brothers, New York and London, 1944. $2.50. (See the review in the *Geogr. Rev.*, Vol. 35, 1945, pp. 168–170.)

Palestine have been put forward by Messrs. Savage and Hays (Commission on Palestine Surveys).[47] In a criticism of these schemes Mr. Ionides[48] suggests that no attention has been paid to the limitations imposed by the actual amount of rain falling within Palestine and propounds the view that some of the envisioned advances in Palestinian agriculture can take place only at the expense of agriculture in other areas, notably Transjordan. "M. G. I.," in an article entitled "Irrigation in Palestine: A Key to Economic Absorptive Capacity" expresses the opinion that Palestine itself "must be regarded as being agriculturally saturated."[49]

An appraisal of Palestine's capacity for survival and growth is made by Professor A. E. Kahn.[50] Limiting his examination to purely economic and even financial factors, Kahn points out that economic conditions in Palestine since the founding of the Jewish National Home cannot be said ever to have been "normal." During the twenty years 1919–1939, Palestine had the heaviest import of capital per head of population in the world; and when this inflow declined after 1939, a "boom" due to war conditions swiftly developed and has so far continued. The conclusion reached, namely that although the present population of Palestine, both Jewish and Arab, can probably be supported from current resources, "continued absorption of immigrants . . . is contingent upon a continued inflow of capital," gives added point to the observations of Notestein and Jurkat.[51]

A detailed discussion of the general economic problems affecting Palestine is given in "Palestine: Problem and Promise: An Economic Study,"[52] of which one can fairly say that it affords an independent and objective survey of current trends and difficulties. Disparity in standards of living as between Arab and Jew is one of the root causes, if not the greatest single element,

[47] A brief statement is given by Abel Wolman, in collaboration with James B. Hays and A. E. Barrekette: Proposed Plan of Irrigation and Hydro-Electric Power Development for Palestine, *Technion Journ.*, Vol. 5, 1946, pp. 37–40.

[48] M. G. Ionides: The Perspective of Water Development in Palestine and Transjordan, *Journ. Royal Central Asian Soc.*, Vol. 33, 1946, pp. 271–280.

[49] *The World Today*, Vol. 3, 1947, pp. 188–198; reference on p. 198.

[50] Alfred E. Kahn: Palestine: A Problem in Economic Evaluation, *Amer. Econ. Rev.*, Vol. 34, 1944, pp. 538–560; reference on p. 560.

[51] Notestein and Jurkat, *op. cit.* (see footnote 39, above).

[52] Robert R. Nathan, Oscar Gass, and Daniel Creamer: Palestine: Problem and Promise: An Economic Study. Prepared under the auspices of the American Palestine Institute. x and 675 pp. Public Affairs Press, American Council on Public Affairs, Washington, D. C., 1946. $5.00.

A lavishly illustrated picture of progress made in Palestine and further possibilities is presented in "Palestine's Economic Future: A Review of Progress and Prospects," edited by J. B. Hobman (310 pp. Percy Lund Humphries & Co., London, 1946. 15s.). This is a book of essays "written by experts actually engaged in Palestine in the schemes and industries under review. Other contributors, like Professor Lowdermilk, Sir John Russell, Professor Laski and Mr. Robert Nathan, have special qualifications and sympathies for discussing the larger pattern of future expansion" (p. 9).—EDIT. NOTE.

of the present tension; and even though at some stage most economic problems are cut across by a political factor, the most fruitful approach to a solution of Palestinian affairs is likely to lie in improvement of living conditions for all concerned.

It is, however, necessary to take into account differences of psychology and temperament that occur in the Arab world. One unfortunate feature of the Western approach to the Middle East is an insistence on material achievement as a criterion of cultural and political development, with the practical corollary that acts of penetration or interference by outside nations are justified if material benefits are conferred. *Timeo Danaos et dona ferentes* is likely to be the Arab reaction to proposals from the West that are sincerely believed by their sponsors to be to the advantage of the Arab himself; and one of the difficulties in Palestine is the hesitancy on the part of the Arab to set any value on economic progress, which is regarded by Zionists as a main justification for the continued immigration of Jews into the country.

A factual background to policies in Palestine is given by a publication of the R.I.I.A.[53] and by a short paper of which the title is the best summary.[54] "The Palestine Impasse" is interesting as the unbiased view of an observer relatively remote from the heat of controversy. A more extensive survey by a writer versed in English, Arabic, and Hebrew and closely in touch with recent developments in Palestine provides an impartial and well-documented exposition of both Arab and Jewish viewpoints.[55] Allowance must be made for the troubles of the mandatory power, which, committed to a contradictory and perhaps impossible policy, was exposed to world-wide, and at times uninformed, criticism; yet it is difficult to resist the conclusion that the British government was unwilling or unable to examine the full implications of its policy for the country and the people. Mr. Barbour goes so far as to suggest that nearly all Palestine's troubles "might be said to come from lack of national direction"; but he also singles out Zionist intransigency and distortion as a contributing factor to difficulties in working the Balfour Declaration. How far this latter opinion invalidates the impartiality of his book will be a matter of personal interpretation.

The wider aspects of Jewish settlement in various countries of the world

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[53] "Great Britain and Palestine, 1915–1945." 3rd edit. xii and 178 pp. *Royal Inst. of Internatl. Affairs Information Papers No. 20,* London and New York, 1946. 7s. 6d. ($2.00).

[54] A. E. Prince: The Palestine Impasse, *Internatl. Journ.: Canadian Inst. of Internatl. Affairs Quart.,* Vol. 1, 1946, pp. 122–133.

[55] Nevill Barbour: Nisi Dominus: A Survey of the Palestine Controversy. 248 pp. George G. Harrap & Co., London, Toronto, etc., 1946. 8s. 6d. (American edition: Palestine: Star or Crescent? x and 310 pp. Odyssey Press, New York, 1947. $3.00.)

are dealt with by the Reverend J. W. Parkes.[56] Although his book is concerned with problems of the Jewish people as a whole, some attention is inevitably focused on Palestine; and in the second part an evaluation of the function of the country in relieving the distress of Jewry gives the author's view that, although achievements have been limited, nevertheless the National Home for the Jews has, on the whole, been of benefit to the people whom it was intended to serve.

In ending this discussion the author desires to reinforce what was said earlier regarding geography and politics in relation to Palestine. Purely political argument derives too closely from naked power for either side to adopt it as the main basis of approach. The Arab League, a possible fruitful beginning to genuine cooperation on a regional level throughout the Middle East, will, if political considerations continue to be its only driving force, ultimately pass into a sterile and disastrous fanaticism. Equally seriously, Zionism cannot risk a full appeal to power politics, since ultimately the balance will inevitably lie to the disadvantage of a small Jewish minority in a Moslem world.

The Middle East is now in many respects a *tabula rasa,* ready to receive the impress of new policies and new human relationships. Forms of society that have endured since the Middle Ages are now in rapid decay and must be replaced by other groupings. As alternatives, we have on the one hand narrow regionalism, leading finally to disruptive nationalism, on the other the opportunity for more fruitful development on a wider scale, following the organization of the Middle East as a single unit.

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[56] John Hadham, pseud. [J. W. Parkes]: The Emergence of the Jewish Problem, 1879–1939. xxiv and 259 pp. Issued under the auspices of the Royal Institute of International Affairs. Oxford University Press, London, 1946. 15s.

EDIT. NOTE. "Of making many books there is no end" applies with singular force to the present status of writings on the Middle East. "The gathering of the relevant titles alone would impose a staggering effort. . . . No two lists of suggested introductory reading about this region are likely to correspond," says E. A. Speiser in "The United States and the Near East." New titles have continued to appear since the final manuscript was received from Dr. Fisher. Two that may be added to his references are Professor Speiser's book and "Palestine: A Study of Jewish, Arab, and British Policies" (published for the Esco Foundation for Palestine). Comments on these books may be found in the review section of this number of the *Geographical Review.*

AGROCLIMATOLOGY AND CROP ECOLOGY OF PALESTINE AND TRANSJORDAN AND CLIMATIC ANALOGUES IN THE UNITED STATES*

M. Y. NUTTONSON

PALESTINE is a land of sharp contrasts—arid wilderness and tilled fields; treeless, overgrazed, eroded hills and carefully managed plantings. Transjordan is largely an elevated plateau, a pastoral country, more arid, but with a relatively greater number of perennial springs and streams. The total area of present-day Palestine is about 10,430 square miles, which is about one-fifteenth of the area of the state of California. It might be described as nearly equal to the area of the coastal strip of California south of the Tehachapi Mountains—part of Santa Barbara County, all of Ventura, Los Angeles, and Orange Counties, and the parts of San Bernardino, Riverside, and San Diego Counties west of the mountains. The area of Transjordan is estimated to be about 34,700 square miles, somewhat more than three times that of Palestine.

If a map of the two countries were to be superimposed on a map of the United States, their northern extremities would lie in the same latitudes as parts of southern California, southern Arizona, southern New Mexico, northern Texas, southern Arkansas, central Mississippi, central Alabama, central Georgia, and southern South Carolina; their southern extremities would lie in the same latitudes as central Lower California, northern Mexico, southern Texas, southern Louisiana, and the southern part of northern Florida.

In its general physical aspect Palestine is not unlike parts of California. The sea breezes and desert winds of Palestine, its diversified, semidesert terrain, its blue sky and maximum of sunshine during most of the year, its warm, wet winters and hot, dry summers, its native chaparral and cultivated crops, its man-made changes in the agricultural-ecological conditions—all find their counterparts in California. Within limits, the general physical aspect of Transjordan is not unlike that of certain parts of Palestine, but terrain and climate are harsher and more arid and suggest only some of the more inland and more arid areas of southern California.

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* Condensation of a study published in offset form by the United States Department of Agriculture. (See the author's study, "Agroclimatology and Crop Ecology of the Ukraine and Climatic Analogues in North America," in the April number of the *Geographical Review*, pp. 216–232.) Table 1 is a selection from the complete chart, which presents data for 72 stations in Palestine and 23 in Transjordan.

Objective and Method of Procedure

The objective of this study is to organize, define, and analyze the various distinct agroclimatic conditions in Palestine and Transjordan and to compare them with agroclimatic conditions in the United States in order to discover "climatic analogues," places enough alike with respect to some of the major weather characteristics affecting crop production to offer a fairly good chance for the successful introduction of plant material from one area to its climatic counterpart.

Meteorological data of all available weather stations of the Palestine-Transjordan territory and of comparable stations in the United States were the main sources of material. The crops grown, the crop geography, and the physiographic and soil characteristics of the various physical belts of Palestine and Transjordan were also considered. The elements of comparison were mean monthly and yearly temperatures, average monthly, seasonal, and yearly precipitation, precipitation-effectivity indices and ratios (Thornthwaite's method), relative humidity, and latitudes.

After these elements of the environment of a given Palestine or Transjordan meteorological station had been computed and studied, a search was made among United States stations for a similar climatic and latitudinal environment. The United States environment found to resemble most nearly that of the Palestine or Transjordan station was recorded as climatically analogous to it. Examples are given in Table 1. In addition to these analogues, analogues for irrigated crops were worked out mainly on the basis of temperature and relative humidity.

A further check of established climatic analogues was obtained through a comparative study of phenological data. The phenological comparisons, together with comparative studies of the summation of the accumulated day degrees required to bring a crop to a definite phenological stage, are to be made available in detail in another paper.

The Topographic Pattern

North of the semidesert Negeb, Palestine is divided topographically into three north-south belts—the maritime or coastal-plain belt, the upland or mountain belt, and the Jordan depression with its 'Araba extension. The Negeb, the southern half of the country, forms a large triangle with its apex at the Gulf of 'Aqaba.

The Maritime Plain is undulating, dune-fringed along the shore and dotted with calcareous sandstone (kurkar) hills. Its area is about 1200 square

miles, its total length almost 120 miles, its width increases southward from a few yards to 20 miles, its highest elevation is not more than 660 feet above sea level. From Tel Aviv to the spurs of Mt. Carmel, about 50 miles to the north, the coastal plain is known as the Plain of Sharon; from Mt. Carmel to its north end as the Plain of Acre or Emek Zevulun; and from Lydda southward for about 60 miles as the Plain of Judea or the ancient Plain of the Philistines.

The dissected uplands, the hill country of Palestine, rise in fairly gentle slopes from the coastal plain to form an elevated tableland, which drops abruptly eastward to the lowest land depression on earth, the Jordan rift or the Ghor. In only a few places is the upland belt more than 3000 feet in elevation. Its area is slightly more than 3700 square miles, more than a third of the entire country. The uplands are divided into two distinct blocks by the broad lowland passage (Emek) of the Plain of Esdraelon and its eastern extension, the Valley of Jezreel. The combined land area of the Plain of Esdraelon and the Valley of Jezreel is about 190 square miles, the greatest length and width 30 and 12 miles respectively.

North of the lowland passage is the rolling hill country of Galilee, with a land area of about 800 square miles; south are the highlands of Samaria and Judea, with an area of 2900 square miles. Upper and Lower Galilee are separated by the Plain of Asochis, 9 miles long from east to west, 2 miles wide, and about 500 feet above sea level. Upper Galilee is a mountainous plateau, about 16 miles from north to south and 25 miles from east to west, the highest point 3963 feet above sea level. Lower Galilee consists of several parallel ridges, which run from east to west with open valleys in between. It is about 28 miles long from east to west and 7 miles from north to south; the highest point is not more than 2000 feet above sea level. Samaria is mountainous throughout but is interspersed with small plains and open valleys. It is some 50 miles long from north to south and 30 miles wide from east to west; its area is about 1600 square miles. The highest point is 3290 feet above sea level. The rounded slopes of Samaria contrast sharply with the rugged Judean plateau, harsher and even more rugged toward the south. From north to south this plateau is about 48 miles in length; from west to east it widens gradually from 15 miles in the north to 25 miles in the south; its highest point is 3336 feet above sea level. The Judean plateau is separated from the Negeb by the Beersheba valley.

The western descent of the Judean highlands is actually in two steps: to the range of low hills known as the Shephelah, and then to the coastal plain. The Shephelah is separated from the main slopes of Judea by a small elevated

plain. It stretches for 30 miles from Samaria southward almost to Gaza and is 5 to 8 miles wide. Its highest point is 1500 feet above sea level, but its average elevation is less than 800 feet.

The Palestinian half of the Jordan Valley occupies about 240 square miles and averages in width from less than 3 miles to more than 14. It is drained by the Jordan River, whose headwaters rise in the north, where the floor of the valley is about 492 feet above sea level, and flow through the Hule Plain—about 72 square miles in area—to form Lake Hule (Waters of Merom). Ten miles to the south, where the Jordan expands into the Sea of Galilee, the valley is nearly 700 feet below sea level; and as the river ends its course in the Dead Sea, the floor of the valley is about 1280 feet below sea level. South of the Dead Sea the depression continues as the plain of 'Araba; its area is slightly more than 300 square miles.

The Negeb has an area of about 4700 square miles, nearly as large as that of the rest of Palestine. It can be subdivided into four districts: an undulating, rectangular-shaped coastal plain occupying nearly 350 square miles; an upland plateau reaching 1650 feet above sea level and occupying about 1300 square miles; an unexplored mountain area, triangular in shape, occupying more than 2600 square miles; and a desert area of nearly 300 square miles.

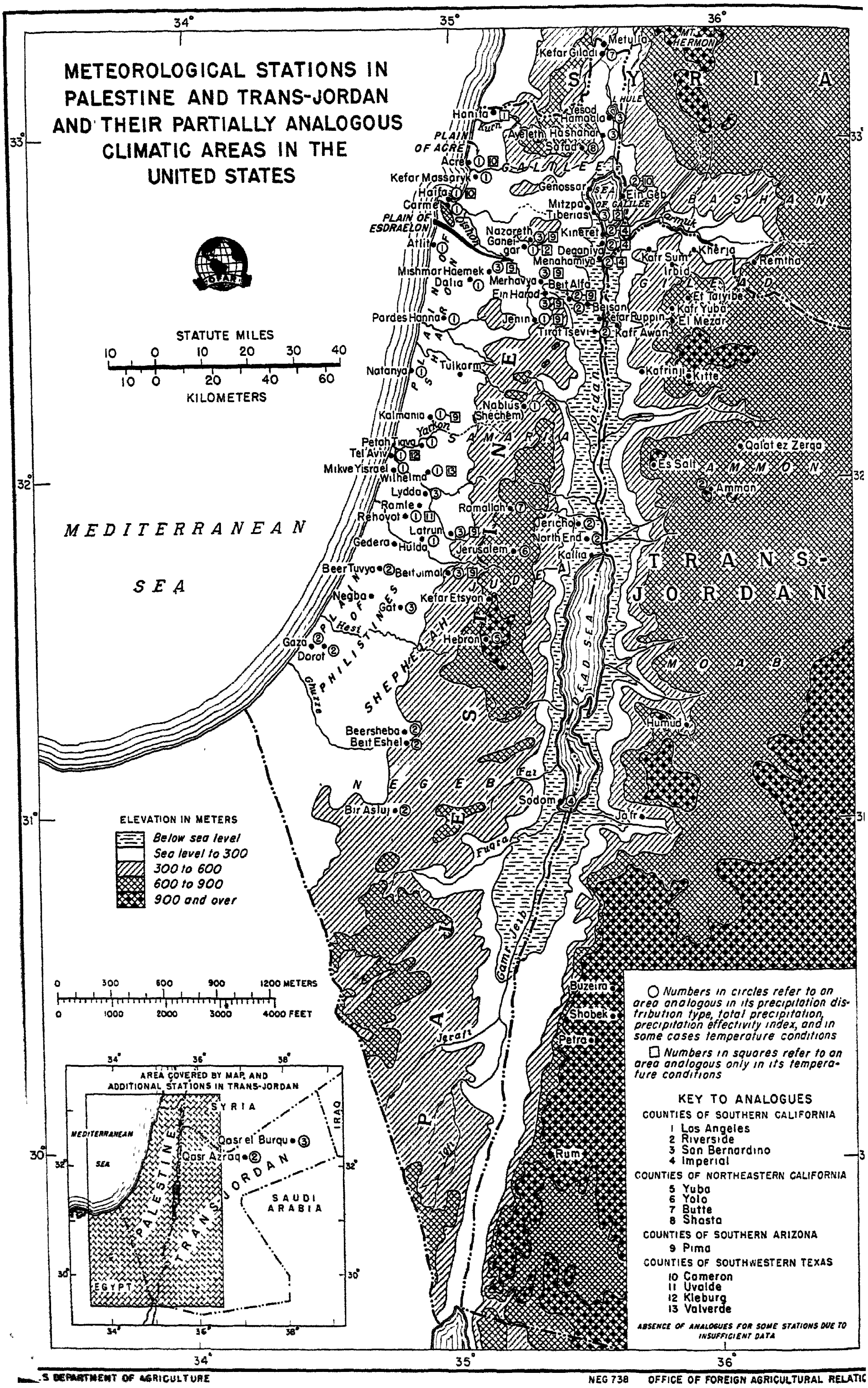
As a whole, the physiography of Transjordan is more uniform in character than that of Palestine, but it, too, may be said to consist of three main regions running in a north-south direction.

In the Jordan rift the eastern half of the Jordan Valley, covering an area of slightly more than 210 square miles, constitutes the western frontier of Transjordan.

The highlands of Transjordan consist of a north-to-south succession of high, wide, discontinuous, ravine-broken mountain blocks and rolling plateaus of various widths, falling steeply to the Jordan depression, with altitudes of more than 4000 feet above sea level in the north and more than 5400 feet in the south. A southern section of the Hauran Plain and the ancient lands of Golan, Gilead, Ammon, Moab, and Edom lie within this region of about 4600 square miles. The plateaus descend gently toward the east and gradually merge into the desert.

The desert of Transjordan, an undulating, arid region with a few oases and water points, occupies more than four-fifths of the area of the country. Its average elevation is more than 1650 feet above sea level, but in some places the elevation reaches more than 3000 feet.

South of the highland region—that is, south of parallel 30° N.—and



METEOROLOGICAL STATIONS IN PALESTINE AND TRANS-JORDAN AND THEIR PARTIALLY ANALOGOUS CLIMATIC AREAS IN THE UNITED STATES
STATUTE MILES
10 0 10 20 30 40
10 0 20 40 60
KILOMETERS
MEDITERRANEAN SEA
ELEVATION IN METERS
Below sea level
Sea level to 300
300 to 600
600 to 900
900 and over
0 300 600 900 1200 METERS
0 1000 2000 3000 4000 FEET
AREA COVERED BY MAP AND ADDITIONAL STATIONS IN TRANS-JORDAN
MEDITERRANEAN SEA
SYRIA
IRAQ
Qasr el Burqu ③
Qasr Azraq ②
PALESTINE
TRANS-JORDAN
SAUDI ARABIA
EGYPT
SYRIA
TRANS-JORDAN
○ Numbers in circles refer to an area analogous in its precipitation distribution type, total precipitation, precipitation effectivity index, and in some cases temperature conditions
□ Numbers in squares refer to an area analogous only in its temperature conditions
KEY TO ANALOGUES
COUNTIES OF SOUTHERN CALIFORNIA
1 Los Angeles
2 Riverside
3 San Bernardino
4 Imperial
COUNTIES OF NORTHEASTERN CALIFORNIA
5 Yuba
6 Yolo
7 Butte
8 Shasta
COUNTIES OF SOUTHERN ARIZONA
9 Pima
COUNTIES OF SOUTHWESTERN TEXAS
10 Cameron
11 Uvalde
12 Kleburg
13 Valverde
ABSENCE OF ANALOGUES FOR SOME STATIONS DUE TO INSUFFICIENT DATA
S DEPARTMENT OF AGRICULTURE
NEG 738
OFFICE OF FOREIGN AGRICULTURAL RELATIC

Fig. 1

Table I—Selected Examples from the Agroclimatic Charts of Palestine and Transjordan and Climatic Analogues in the United States

For each station in Palestine and Transjordan the latitude and altitude (feet) are given. Line *T* gives mean monthly and yearly temperatures (°F.) and absolute maximum and minimum temperatures. Line *P* gives precipitation, monthly and yearly (inches), and precipitation-effectivity index (P/E). Line *R* gives relative humidity (per cent). "*U.S.*" indicates climatic analogue in the United States based on annual distribution of precipitation and P/E index and in most cases temperature. "*U.S. Suppl.*" indicates climatic analogue based on temperature conditions only.

		J	F	M	A	M	J	J	A	S	O	N	D	Year	Max.	Min.
Tel Aviv	*T*	55.0	58.0	61.0	66.0	71.0	76.0	80.0	81.0	78.0	73.0	66.0	58.0	69.0	115	37
32°04′	*P*	5.6	4.5	0.6	0.6	0.2	0.0	0.0	0.0	0.1	0.8	3.1	5.2	20.8	P/E	36.9
105 ft.	*R*	85	87	82	75	78	80	80	76	74	77	81	77	79		
	U.S. Azuza, S. California, 34°03′; 540 ft. Somewhat cooler. 2 in. less precip.															
	U.S. Suppl. Ricardo, S.W. Texas, 27°20′; 35 ft.															
Acre	*T*	56.0	56.0	59.0	64.0	69.0	73.0	80.0	81.0	77.0	73.0	68.0	59.0	70.0	110	34
32°55′	*P*	5.5	7.9	0.9	0.7	0.2	0.0	0.0	0.0	0.2	1.3	4.1	3.7	24.5	P/E	43.4
61 ft.	*R*	72	77	68	67	66	70	74	73	68	62	65	70	70		
	U.S. Sierra Madre, S. California, 34°04′; 1100 ft. Somewhat cooler.															
	U.S. Suppl. Raymondville, S.W. Texas, 26°30′; 31 ft.															
Jerusalem	*T*	47.0	48.0	55.0	61.0	69.0	73.0	75.0	75.0	73.0	69.0	62.0	52.0	63.0	107	26
31°47′	*P*	4.1	5.3	1.1	1.0	0.1	0.0	0.0	0.0	0.0	0.2	1.2	2.9	15.9	P/E	34.1
2485 ft.	*R*	78	72	60	52	44	46	50	55	60	58	62	73	69		
	U.S. Davis, N.E. California, 38°30′; 51 ft. Slightly cooler winters.															
Ein Harod	*T*	53.1	56.7	59.9	68.9	74.1	79.7	81.5	82.2	79.0	75.2	68.4	56.1	69.6	108	37
32°33′	*P*	4.7	3.6	1.3	0.8	0.2	0.0	0.0	0.0	0.0	0.9	2.1	4.5	18.7	P/E	33.5
14 ft.	*R*	74	75	71	76	67	69	72	77	67	62	65	70	71		
	U.S. Redlands, S. California, 34°01′; 1352 ft. Somewhat cooler. 3 in. less precip.															
	U.S. Suppl. Silverbell, S. Arizona, 32°25′; 2990 ft.															
Nazareth	*T*	49.0	54.0	56.0	63.0	68.0	74.0	78.0	79.0	77.0	75.0	65.0	54.0	66.0	111	25
32°42′	*P*	6.3	4.6	3.7	1.0	0.2	0.0	0.0	0.0	0.0	0.8	3.4	7.1	27.1	P/E	54.2
1608 ft.																
	U.S. Mill Creek, S. California, 34°01′; 2950 ft. Somewhat cooler. 3 in. less precip.															
	U.S. Suppl. Fresnal School Ranch, S. Arizona, 32°; 4000 ft.															
Dan	*T*	51.3	54.9	58.1	64.9	72.7	79.2	80.8	81.1	78.4	74.7	64.6	55.2	68.0	93	35
33°15′	*P*	13.3	2.6	2.1	0.8	0.4	0.0	0.0	0.0	0.0	0.2	0.0	2.9	22.3	P/E	47.5
492 ft.	*R*	83	73	73	73	65	64	61	69	72	72	65	70	70		
	U.S. Marysville, N.E. California, 39°05′; 67 ft. Somewhat cooler. 2 in. less precip.															
Jericho	*T*	57.0	59.0	65.0	72.0	80.0	85.0	88.0	88.0	85.0	80.0	71.0	60.0	74.0	120	36
31°51′	*P*	1.3	1.3	0.2	0.4	0.1	0.0	0.0	0.0	0.0	0.1	0.4	1.2	5.0	P/E	7.1
−820 ft.	*R*	70	68	56	48	43	44	45	46	52	54	59	66	54		
	U.S. Palm Springs, S. California, 33°59′; 584 ft.															
Beersheba	*T*	54.0	54.0	60.0	66.0	73.0	77.0	79.0	80.0	77.0	73.0	67.0	58.0	68.0	115	23
31°14′	*P*	1.9	2.2	0.7	0.4	0.1	0.0	0.0	0.0	0.0	0.1	0.8	1.6	7.8	P/E	13.0
938 ft.	*R*	78	75	67	57	53	59	67	67	70	66	67	72	66		
	U.S. Riverside, S. California, 34°; 851 ft. Somewhat cooler. 2 in. more precip.															
Amman	*T*	48.8	49.1	56.7	60.3	74.3	78.0	77.0	79.8	75.0	70.4	56.2	52.0	64.8	109	21
31°57′	*P*	2.5	3.3	0.8	0.8	0.1	0.0	0.0	0.0	0.0	0.1	1.3	1.6	10.5	P/E	21.2
2548 ft.																
	U.S. San Jacinto, S. California, 33°52′; 1500 ft. Slightly cooler.															
Osar Azraq	*T*	47.0	50.0	59.0	68.0	75.0	82.0	85.0	87.0	76.0	70.0	59.0	50.0	67.0	113	55
32°15′	*P*	0.6	0.8	0.3	0.3	0.2	0.0	0.0	0.0	0.0	0.1	0.6	0.7	3.5	P/E	5.8
2624 ft.																
	U.S. Blythe, S. California, 33°35′; 268 ft.															

extending all the way to the Gulf of 'Aqaba is the climatically distinct sandy region, El Hásma.

Climate and Climatic Analogues in the United States

The fairly abundant meteorological data for Palestine, and even the meager and fragmentary data for Transjordan, reveal a considerable regional diversity. Yet the dominant climatic features suggest a certain essential unity. The occurrence of two sharply divided and well-marked seasons, a rainy, mild winter and a dry, hot summer; the very short, or virtually absent, transitional periods, with no regular sequence of weather; the great amount of sunshine and the bright, cloudless skies throughout the long summer; the hot, dry desert winds during the spring and fall are all common to most of Palestine and Transjordan. They are also characteristic of parts of California.

Palestine lies in the transitional region between the comparatively moist Mediterranean lands and the deserts of Asia and Africa. It is subject to the influence of both sea breezes and desert winds. In summer the sea breezes exert a cooling, moderating effect and raise the humidity; in winter they exert a warming effect and bring rain. These effects are pronounced in the coastal plain, and to some extent along the western slopes of the mountain belt also. They are less pronounced east of the uplands divide, and also from north to south. Transjordan is much less subject to such influences. On the other hand, both countries are more or less open to the influence of the desert. This is manifested in the khamsin, a hot, dry, oppressive, dust-laden wind from the deserts of Arabia. The khamsin may occur in all seasons except summer but blows mainly from April to May and from September to November. In many respects the khamsin is not unlike the harsh and burning desert winds that blow in May and in late August in the great valleys and the southern parts of California. Another manifestation of desert influence is the strong, dry northeast or east winter wind, which brings with it the cold and the low humidity of the desert. This winter wind, known as the cold sirocco, is distinct from the usually much weaker southeast hot sirocco or khamsin wind of spring and fall. The relative humidity of the air is about equally low during both the siroccos. The hot springtime desert winds are of greatest danger to horticultural crops during blossom and fruit setting and to cereal crops during heading and between the end of the milky-ripe and the end of the yellow-ripe stages of ripening. Desiccation and the abscission of blossoms and fruit set, empty spikelets and shriveled grain, are among the direct effects of the hot sirocco. The

cold sirocco at sprouting time may cause desiccation of the young sprouts, possibly freezing of tree-plant tissues.

The hottest month of the year is August, the coldest January. In general, temperature ranges increase with distance and shelter from the sea; temperatures decrease as altitude increases. At the same altitude and distance from the sea, precipitation is greater in the north than in the south; in the western watershed it is greater on the high ground than on the plains; and it is greater also west of the divide than farther inland. The relative humidity depends largely on the wind direction, especially in the coastal belt and on the western slopes of the mountain belt. Annual temperatures on the coast do not decrease with latitude; for example, the mean annual temperature at Gaza is 67° F., at Tel Aviv 69°, and at Acre 70°.

TABLE II—RANGE OF CLIMATIC CONDITIONS IN PALESTINE AND TRANSJORDAN AND ILLUSTRATIONS OF CONDITIONS IN THE SEVERAL BELTS OF PALESTINE

	Palestine	Transjordan	Tel Aviv	Jerusalem	Jericho	Beersheba
Precipitation						
Aver. Ann. (in.)	1–38	2–23	20.8	15.9	5.0	7.8
P/E Index	1–76	3–22	36.9	34.1	7.1	13.0
Aver. Ann. Rel. Hum. (%)	47–79	—	79	69	54	66
Temperature °F.						
Mean Coldest Month	43–61	47–58	55	47	57	54
Mean Warmest Month	73–92	80–87	81	75	88	80
Mean Annual	56–78	64–71	69	63	74	68
Absolute Max.	86–120	109–113	115	107	120	115
Absolute Min.	19–46	21–55	37	26	36	32
Day Degrees above 50°F.						
Between May 1 and Oct. 1			4162	3519	5385	4162
Between Oct. 1 and May 1			2641	1496	3464	2497
Total			6803	5015	8851	6659

Figures from a few selected meteorological stations of Palestine (Table II) illustrate in a general way the major climatic characteristics of the four divisions; the meteorological data are too meager to permit a similar comparison for Transjordan. The stations of the three parallel topographic belts of Palestine are in approximately the same latitude; the Negeb station is not quite 1° to the south. It will be noted that precipitation and precipitation-effectivity indexes vary greatly with altitude; distance from the sea is not the sole factor. Although the mean and maximum temperatures of the Negeb are almost the same as those of the Maritime Plain, its minimum temperature is lower, and its relative aridity is high. South of Beersheba the aridity and the range of temperature are even greater.

The rainy season of Palestine and Transjordan begins in October or November and ends in April. Most of the precipitation falls in the Novem-

ber-March period; little, if any, occurs in May, and usually none at all from May to October except for occasional and exceptional showers due to thunderstorms. The "first rains," the "main rains," and the "late rains" are the three phases of the local rainy period. The first or "former" rains take place in October and November; the main rains in December, January, and February; the late or "latter" rains in March and April. Rainfall is heaviest on the coast; the late rains are heavier than the first in inland areas but not on the coast.

Exceptions to this rainfall distribution are not infrequent. In the rainy season itself there are at times prolonged dry periods. The interval between main and late rains is especially long, and in some years the late rains do not occur at all. There have also been years in which the first rains have failed completely. On the other hand, there are years in which precipitation is considerably greater than normal. The rainfall ranges in intensity from gentle showers to violent storms and cloudbursts.

Fairly satisfactory climatic analogues for most of the Palestine and Transjordan meteorological stations used in this work were found to be available in the United States. On the basis of similarity of precipitation distribution, precipitation-effectivity indexes, and, in most but not all cases, temperatures and relative humidity the United States climatic analogues are limited mainly to the southern part of the state of California. For some stations, however, the temperatures and the summations of heat units were found to correspond more nearly to those of parts of southern Texas and Arizona. Also, the relative humidity of a considerable number of Palestine stations is too high for even the southern coastal areas of California and suggests instead areas in the lower Rio Grande Valley of Texas and in southern Florida. The sparse observational data on the relative humidity of California, Arizona, Texas, and Florida do not permit a more comprehensive comparative study and a more concrete utilization of the extensive relative-humidity data of Palestine.

For dry farming areas the precipitation-distribution pattern and the precipitation-effectivity index, as well as the actual amount of precipitation and temperature conditions, are considered to be of greatest importance in determining climatic analogues. For areas under irrigation, however, a combination of temperature and relative-humidity data may be useful in suggesting climatic counterparts, even though the precipitation patterns do not match. Analyses of plant reactions to the various climatic influences, or to combinations of certain of these influences, would be extremely valuable for purposes of plant introduction, but not much has been done

along this line. Some general surveys suggest that the climatic adaptation, behavior, and responses of some varieties of horticultural and agronomic crops under irrigation, and also the occurrence and prevalence of certain plant pests and diseases, may be related to their thermal and atmospheric-humidity environment.

Most of the meteorological stations of the Plains of Judea, Sharon, and Acre and those of Samaria and of a part of the Plain of Esdraelon find their nearest climatic counterparts in the southern coastal area of California, specifically in Los Angeles County. However, the temperatures of some of these stations and their total heat-summation units are too high for coastal southern California and suggest rather places in certain counties of southeastern California, southwestern Texas, and southern Arizona. Similarly, most of the meteorological stations of southern Palestine and of the Negeb, those of the Jordan Valley and the Transjordan plateau, and a few stations of Judea, Lower Galilee, and the Valley of Jezreel find their climatic counterparts in the southeastern part of southern California, in San Bernardino, Riverside, and Imperial Counties. Some of these stations, however, are subject to a warmer thermal regime suggesting more nearly that of Pima County in southern Arizona. A few stations of Upper Galilee and the mountains of Judea find their approximate climatic analogues in northeastern California in the counties of Yolo, Yuba, Butte, and Shasta.

Agroclimatic Conditions of the Various Areas

The coastal plain of Palestine has a rather narrow daily and annual range of temperature and the high relative humidity characteristic of a distinctly maritime climate. The summers are warm, the winters mild. The relative humidity is fairly high, except on the few days on which the sirocco winds blow from the desert. The total amount of dew is large, since it forms throughout much of the year.

The mountain belt has cooler and drier summers, colder winters, and a wider daily and annual range of temperature, though it must be emphasized that conditions are far from uniform. Besides differences due to altitude and the progressively greater aridity southward, there is also the pronounced climatic difference between the western and eastern watersheds. From an average of 20 inches and a maximum of more than 30 inches on the western slope, the precipitation drops to as little as 4 inches a year in parts of the eastern slope.

In general, the coastal plain, the Plain of Esdraelon, and the western slopes of the mountain belt of Palestine and a few areas of the highlands of

Transjordan are subject to mild and fairly moist winters and hot and dry summers, a condition that permits a fairly satisfactory dry farming of winter and summer field crops, the growth of certain fruits, such as the olive, almond, European grape, and carob, without irrigation, and the existence of natural and man-planted forests. In the parts of Transjordan where a relatively satisfactory dry-farming production of field crops is possible, temperatures are more extreme than in the corresponding dry-farming areas of Palestine.

The Jordan Valley is characterized by warm winters with scanty precipitation and very hot and dry summers, a relatively large number of very dry sirocco days, and a wide daily and annual range of temperature. Here, too, precipitation increases with increase of altitude and latitude. The total heat-summation averages for the May-October period (computed above 50° F.) are about 2000° higher for the Jordan Valley than for the coastal plain, and somewhat the same thermal difference seems to exist between the westernmost and easternmost parts of the Plain of Esdraelon–Valley of Jezreel.

The eastern slopes of the mountain belt of Palestine (including the wilderness of Judea and Samaria), the northern Negeb, the southern part of the upper Jordan Valley, and large areas of Transjordan have a semiarid type of climate that permits a rather unstable dry farming. The moisture from the total yearly amount of dew in the Negeb is said to be greater than that obtained from the annual rainfall. No fruit-tree culture is possible in these areas without irrigation, and no natural forests occur here. Instead, the natural vegetation consists of sparse, short grass and shrubs.

The southern Negeb, the lower Jordan Valley, the 'Araba region, and southern and eastern Transjordan are subject to an arid desert climate. The irregular and scanty precipitation does not permit any dry farming except in the highly water-retentive loess areas. A number of oases well supplied with water are intensively cultivated, and their vegetation is vigorous and luxuriant.

Of all the climatic factors, the precipitation, both its amount and its regularity, seems to be the most decisive in determining the agricultural possibilities of the dry-farming areas of Palestine. In the coastal plain, precipitation increases from 13 inches at Gaza to 24 inches at Haifa; in the mountain belt, from 16 inches at Jerusalem to 27 inches at Nazareth and 36 inches at Safad; in the Jordan Valley, from 5 inches at Jericho to 20 inches at Tiberias; and in the Negeb, from approximately 1 inch at Sodom to 8 inches at Beersheba.

The averages of Table III, however, are only rough indications of the relative annual amounts of precipitation in the various areas of Palestine. Actually, there are considerable variations. Moreover, in addition to the quantity of precipitation, its distribution, and its regularity, the intensity is of agroecological importance, especially under certain topographical and physical soil conditions. Much of the rainfall occurs in heavy downpours,

TABLE III—YEARLY PRECIPITATION IN VARIOUS AREAS OF PALESTINE
In Inches

Coastal Belt		Hill Country	
1. South	17.4	1. Judea	21.4
2. Plain of Judea	20.7	2. Samaria	22.7
3. Plain of Sharon	21.3	3. Lower Galilee	25.4
4. Plain of Acre	27.2	4. Upper Galilee	26.8
Plain of Esdraelon and Valley of Jezreel	19.9	Valley of Jordan	13.4
		Negeb	5.3

which cause runoff and soil erosion on the mountain slopes and floods in the plains and valleys. Fluctuations in precipitation are especially pronounced in the more arid parts, in the areas of unstable dry-farming agriculture.

In many of the arid areas the rainfall is insufficient or too poorly distributed for farming, even under alternate-cropping, bare-fallow, dry-farming methods and resort must be had to irrigation.

The scanty meteorological data for the Transjordan plateau do not permit a closer comparative study of the diversity of its climate. As a whole, however, it is subject to a more continental regime than Palestine, with lower humidity, more frequent frosts, and greater extremes of temperature. Aridity increases eastward and southward. Mountainous Gilead has sufficient precipitation to permit a type of agriculture not unlike the relatively stable field-crop dry farming of the western slopes of the mountain belt of Palestine. Winter and summer field crops and olives, grapes, and various deciduous fruits are grown here without irrigation. Ammon, Moab, and northern Edom have less precipitation; and, although fairly satisfactory dry farming of field crops seems to be possible, no fruits can be grown in this way. The eastern semidesert area of Transjordan resembles the semidesert northern Negeb, with its unstable dry farming; the agriculture of the desert areas of southern and eastern Transjordan is, like that of the desert areas of Palestine, limited to oases where irrigation facilities are available.

More than two-thirds of the total rainfall of Palestine and Transjordan usually falls between December and May; that is, during the growing period of the locally winter-sown spring wheat, the predominant crop on nonirrigated land. In most years wheat is seeded in December, after the

heavy rains have set in, though at times it is sown in November. The essential consideration seems to be the sowing of winter crops early enough to ensure the maximum use of winter precipitation. The ecological conditions of the wheat culture of Palestine suggest those of California in the winter growing of spring-wheat varieties and the commercial production of Australian soft-wheat varieties. The phenological data—the dates of sowing, germination, tillering, shooting, heading, and ripening—are generally about the same.

The coastal plain of Palestine, the country's main citrus belt, seldom has frost, and frost is almost completely unknown in the hot, dry Jordan Valley, the chief date-palm area. Frosts are not infrequent, however, in the mountain belt, the main center of the deciduous-fruit culture.

The harvesting of winter crops usually begins in May-July, according to the region and the crop. In the Jordan Valley the harvest of cereals is more than a month ahead of the harvest in the mountain area and about two or three weeks ahead of the harvest in the coastal plain. This is also more or less true of a number of varieties of vegetable and fruit species. The greater the heat summation of an area, the earlier the date of maturity of a given variety of crop species.

The effect of the various thermal environments on the maturing of crops is illustrated by the ripening dates of some varieties of table grapes: early ripening, between June and August, in the Jordan Valley, the Valley of Jezreel, and the Negeb; midseason ripening, between July and September, in the Plain of Sharon, the Shephelah, and the foothills of Judea, Samaria, and Galilee; late ripening, between August and November, in the mountainous districts of Judea, Samaria, and Galilee. However, the time of the rainy season, which in the mountains extends considerably later into the spring than in the plains and valleys, must also be considered among the important factors determining the date of harvest in dry-farming areas. The agriculturally highly important late rains constitute from 12 to 20 per cent of the total annual precipitation of the mountain belt, whereas in the plains and in the valleys they represent only 8 to 10 per cent.

Another effect of temperature is seen in the distribution of subtropical, tropical, and deciduous fruits. A comparison of the degree summations of the daily mean temperatures between May 1 and October 1 (Table II) finds the date-growing Jordan Valley to be the warmest belt of Palestine and the one that most nearly resembles many high-temperature-summation areas of the torrid parts of the United States, where successful and large-scale production of the better varieties of dates is possible. The heat summation

of 5385° for the May–October period at Jericho, computed above a base of 50° F., compares favorably with the heat summations computed on the same base and for the same period of the two main American centers of date-palm culture, Coachella Valley in California (5750° for Indio) and the Salt River Valley in Arizona (5050° for Tempe). Using the base of 64.4° F., the zero point for the date palm, we find that the May-October total heat summation for the Jordan Valley is: 3720° for Jericho; 3907° for Dagania; 3602° for Tiberias; and 3221° for Beisan. The corresponding figures for Indio and Tempe are 4020° and 3018° respectively.

Soil Types and Their Crops

The soils of the mountains of Palestine and Transjordan are mainly heavy, of various degrees of water-holding capacity, fertility, and depth. They are largely of limestone origin; some parent limestones are hard, others chalklike and soft. There are also volcanic basalt soils in the highlands of eastern Galilee and in the northern part of the Transjordan highlands. Because of their structure and topography, the intensity of the rainfall, and the lack of an adequate vegetation cover, the mountain soils are apt to be badly washed. Many areas have been denuded, or practically so, as the result of deforestation and overgrazing and the consequent soil erosion. These areas and the numerous stony or too steep mountainsides constitute the larger part of the uncultivated land in this belt. However, where the soil has been terraced or otherwise protected and the land is not too steep or too rugged, such areas—and also the few broad uplands and mountain valleys—are intensively cultivated, devoted mainly to the production of winter and summer grain crops. Fruit-tree culture without irrigation is also practiced in the mountain areas with favorable precipitation and soils. The usual winter field crops of the mountains are wheat, barley, lentils, chick-peas, and vetch, the summer crops mainly sesame and durra. The typical tree culture of the unirrigated mountain areas includes olives, grapes, figs, carobs, pomegranates, almonds, apricots, apples, pears, and plums.

Washed-down alluvial soils are characteristic of the main grain-producing valleys and plains—the Valley of Jezreel, the Plain of Esdraelon, the Haifa-Acre Plain, the Plain of the Philistines, the Shephelah, and the plains east of the light-soil plantation strip of the coastal belt. The deposits are usually of considerable depth, heavy in texture, fairly uniform in structure, of high water-holding capacity, and productive; and their flat or gently sloping surface is conducive to mechanized farming.

The alluvial soils are derived from either limestone or basalt, or both,

according to the parent material of their sources in the mountains. The water seepage and drainage of many such soil areas are usually poor, and some of them are subject to expansion when wet and contraction and cracking when dry, which make them rather difficult to handle. There are also alluvial sedimentary soils of floodwater or marshy origin, such as those of the Hule Plain, which contains some peat soils in addition, and areas alongside streams in the Jordan Valley and in the coastal plains. As a whole, the alluvial-soil areas constitute the major granary of the two countries and are intensively cultivated, producing winter and summer field crops both under dry farming (wheat, barley, corn, durra, sesame, lentils, and vetch) and under irrigation (clovers, alfalfa, corn for fodder, etc.). Various forage and vegetable crops are highly important. On the better-drained soils there are also fruit cultures, such as grapefruit, olives, grapes, and certain other deciduous fruits.

The diluvial soils of the Jordan Valley have been formed partly from the alluvial limestone washed down from the eroding hill slopes and partly from the sedimentary deposits on the former lake bed. The soils are usually deep, and where they are not too alkaline or where they can be leached of salts, they are suitable for production of irrigated crops—dates, bananas, citrus fruits, and a great number of other fruits of subtropical and tropical origin. Grapes and various out-of-season vegetables are also grown. Indian corn, alfalfa, and clover are among the other irrigated crops.

The coastal plain of Palestine consists largely of light sandy or sandy-loam soil. As much as 80 per cent, possibly more, is pure sand; clay and rock dust make up the remainder. The soil absorbs water readily, but its moisture-holding capacity is rather poor; it is deficient in lime. On the other hand, it warms up rapidly, is well aerated, and is free from excessive salinity. Of great agricultural importance is the occurrence in the deep, light soils of the coastal plain of an impermeable sandy-clay substratum, "saqye," at a depth moderate enough to permit fairly economical lifting of underground water for irrigation. Citrus plants are intensively cultivated; other subtropical, semitropical, and tropical fruits are grown, and also various vegetable and fodder crops. This soil is not too well suited to dry-farming crops.

The designation "light-soil or citrus belt" often used in referring to this area actually does not apply to the whole of the coastal plain; the eastern, northern, and southern margins have heavier alluvial soils, which are largely devoted to grain crops. Within the area of deep, light soils itself, especially on the Plain of Sharon, there are plots of heavier soils with a compact

hardpan of varying thickness at an average depth of less than three feet. This hardpan, known locally as the "nazzaz" layer, forms an impenetrable barrier to plant roots, restricts the movement of water in the soil, and prevents successful tree culture.

Along the Mediterranean shore and the immediate hinterland, windblown and mobile sand dunes are a menace to adjacent farmlands. Windblown deposits of pure sand occur also in the Negeb and in southern Transjordan. Besides the sands, there are extensive and continuous areas of wind-transported loess soil in the plateau region of the Negeb and in Moab and Edom. The loess is a semilight soil, 50 to 80 per cent fine sand particles, the rest fine silt, clay, and limestone particles. Its depth varies, but it is in the main a fairly deep soil, rather easy to handle, slow both to absorb and to yield water. It is mostly free from excessive salinity and is considered one of the most fertile soils of the semidesert areas. In spite of the low—6 to 10 inches a year—and fluctuating rainfall, the high moisture-retentive property of the loess and the abundant nightly dewfall permit semistable dry farming. Wheat and high-quality malting barley are the main field crops; but summer dry farming is the exception rather than the rule. Under irrigation, the loess soil is also suitable for various fodder, vegetable, and fruit crops.

In the undulating coastal plain of the Negeb there are deposits of loess soil covered with a layer of sand. These have a better water absorption, and are better protected from moisture evaporation, than the loess soils without the sand-mulch cover. Their agricultural possibilities are correspondingly greater: they permit the dry-farming production of summer crops, such as durra and watermelons, in addition to winter wheat and barley. Some fruit trees, mainly almonds, will occasionally grow without irrigation in these areas.

Certain parts of the coastal-plain belt have alkali soils, developed as a result of application of water of high salt content and improper methods of irrigation. It is, however, the arid southern part of the Jordan Valley and its 'Araba extension that have the largest acreage of saline soils. These salines are mostly of the white-alkali type and do not contain sodium carbonate.

At the north end of the Dead Sea, where the salinity is very high, experimental reclamation involving repeated leachings has been reported to be encouraging. The salinity has been reduced from 17 to less than 1 per cent, and the formerly desolate area is now under intensive cultivation. The frostless winters and long, hot summers of the valley permit, under irrigation, intensive production on the alkali-free soils of a number of valuable

crops, including alfalfa, clover, various early vegetables, dates, bananas, citrus, and numerous other tropical and subtropical fruit plants. The possibilities are an incentive to reclamation of the nearly 75,000 acres of saline land in the valley.

Summary of Some Climate-Crop-Soil Relationships

Cereal growing is the most important agricultural enterprise of the great majority of the nonirrigated farms. Cereal crops predominate in the native rain-fed agriculture of the two countries, in which winter-sown wheat and barley and summer-grown durra and sesame are the chief crops. Satisfactory summer crops are usually difficult to grow in most areas unless the land has been fallowed during the preceding winter to conserve the soil moisture. The crop-rotation systems practiced by the native farmers are of three main types: a two-year rotation in which wheat or winter barley is followed by durra or sesame or by a winter legume; a three-year rotation in which a legume is introduced as an additional winter crop between the summer and winter cereals; a monoculture of barley alternating with a year of bare fallow in the more arid areas. In the typical native rotation, wheat, or barley, is sown in November and December and harvested in May and June. The land is then left bare until the following April, when it is sown with durra or sesame. This is harvested in August and is followed by a winter cereal again or, in a three-year rotation, by a legume. In many of the European-type settlements of Palestine, a four-year rotation for rain-fed agriculture has been adopted, which includes a hay, silage, or green-manure crop.

Wheat is grown in practically all the regions of Palestine and in many parts of Transjordan. In general, the heavier and deeper soils of the cereal-growing areas are devoted to wheat, the lighter and shallower soils to barley. In the south, where the rainfall is lighter and the rainy season shorter, barley is the leading crop. The great alluvial plains and valleys, with their deep and heavy soils of high water-holding capacity, and the fairly extensive plains of some of the mountain plateaus are the best wheat areas. However, a considerable part of the wheat is grown on relatively small shallow-soiled strips of the mountain terraces, slopes, and foothills. The local wheat consists mainly of a number of native drought-resistant durum varieties, a few Australian soft-wheat varieties, and some semisoft hybrids of the two. Early ripening is a highly important characteristic for the local conditions, because late varieties are likely to be damaged by hot sirocco winds in early May if caught during their yellow-ripe stage.

Sesame requires more moisture than durra and is almost entirely con-

fined to the northern parts, where precipitation is more favorable. Durra is grown in most of the agricultural areas and is the summer crop of the areas of relatively low rainfall. Corn is grown without irrigation mainly in the north. Chick-peas and lentils, peas, beans, and vetch are the principal winter legumes.

In these subtropical countries fodder crops and many vegetable and fruit crops are mostly grown under irrigation. In the more arid areas irrigation is also needed for the satisfactory production of field crops. Irrigation permits not only a more intensive production but also the cultivation of a greater variety of crops and a wider rotation system. It results in higher yields, permits the growth of more than one crop a year, and favors a sounder and more rational utilization of the highly diverse thermal and soil conditions of the two countries. Cultivation of citrus fruits, bananas, forage and fodder crops for dairy farming, and a great number of vegetable crops has been made possible through irrigation.

The mild winters of the coastal plain, the almost complete absence of damaging frosts, the high total summation of heat units and sunshine throughout the long growing period, the relatively high atmospheric humidity, and the adequate supply of irrigation water, in conjunction with the light, deep soils of the main part of this belt, are all conducive to good growth and yield. They permit an intensive cultivation of the various citrus species, bananas, and numerous other subtropical and tropical fruits and the production of a great number of vegetables during most of the year, and also of various fodder crops. The light-soil region of the coastal plain, formerly the center of the grape-growing industry of Palestine, is now almost completely devoted to citrus culture. Orange trees are usually planted on the lighter soils, grapefruit trees on both light and heavy soils. The chief citrus fruit of Palestine is the orange, of which the true Jaffa or Shamooti is the best and most widely grown variety; the Washington Navel and the Late Valencia are also grown to some extent. The Marsh Seedless grapefruit and a number of lemon varieties, including the Eureka, are also raised. Tangerines and citrons are among the citrus species of minor importance.

Out-of-season, early, or winter vegetables, dates, bananas, citrus fruits, and many other tender subtropical and tropical fruits with high heat requirements are grown under irrigation in alkali-free loam and clay soils of the Jordan Valley, where the winters are warm and frostless and the summers long and very hot. The Jordan Valley is also the main alfalfa region of the two countries because of the favorable physical properties and fertility of its soil.

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Use has also been made of many articles appearing in *Hassadeh*, Tel Aviv.

A LETTER FROM PALESTINE

This letter, from Dr. D. H. Kallner of the Palestine Meteorological Service will be found of interest in conjunction with the preceding articles on the Middle East and Palestine. Dr. Kallner is coauthor of "The Geographical Regions of Palestine," published in the January, 1939, number of the "Geographical Review."

JERUSALEM, February 13, 1947

DEAR DR. WRIGHT:

I suppose that you get the news about Palestine in a somewhat one-sided and distorted form, covering mainly political items, terrorist outrages, etc. But many new and constructive developments are taking place which are of considerable interest to the geographer. Some of these are the result of war activities and adjustments, others are not. I shall begin with those of the first category.

The most important feature here is the vast development of small industry. The combination of the cessation of many industrial supplies to the Near East at the beginning of the war with the availability of a reservoir of skilled labour and directing personnel in the Jewish population brought about this development. These plants, most of them of modest size, produced both for the armed forces and for the civilian market. Some of them brought considerable advance in lines already existing before the war; for example, textiles, shoes, agricultural machinery, fruit and vegetable canning, and sweets. Others are new in Palestine; for example, tools and fine-mechanic workshops, and a fair-sized diamond-cutting industry, Palestine's most important single industrial contribution to the war effort. A more limited development of simple industries has taken place in the Arab sector as well, one of the most important of which is the home weaving industry of Majdal near Gaza, producing characteristic blue linenware.

During the early months of the war one of the chief industrial establishments in Palestine assumed full-scale production—the oil refineries at Haifa, processing oil from the fields at Kirkuk in 'Iraq and owned by the Consolidated Refineries, Ltd. Resuming their rather "secret" proceedings of prewar days, the oil companies are now prospecting in southern Palestine in the Gaza district and the Negeb.

A direct result of the war is the dense network of metalled roads crisscrossing the country and making it accessible to motor travel as never before. The development of roads is not yet matched by the motor vehicles. Most of those have been in use since prewar days and need replacement, especially the busses and taxis, which are of particular importance in Palestine because of the inefficiency of the railways. Only recently has the Government begun to make available dollars for purchase of American cars, best suited to this country and therefore highest in demand.

The only—but very important—expansion of the railway network is the line (Haifa)-Acre-Beirut-Tripoli, which with a number of tunnels was built along the coast by Army engineers in connection with the Syrian campaign.

The next item is maps [see the note on "Maps from the Survey of Palestine" in the record section of this number of the *Geographical Review*.—EDIT. NOTE]. These, as usual, benefited directly from the war. Today most of the area north of Beersheba and west of the Jordan is covered by map series on the 20,000, 25,000, 100,000, and 250,000 scales, and a 1 : 50,000 series is in course of production by the Army Survey Directorate. Not all these

series are up to the standards of quality the geographer would wish, but it would be more than ungrateful not to acknowledge the vast progress made. An important item in this connection is the 1:100,000 map of Transjordan in 20 sheets with 25 m. contours (the so-called 1:100,000 South Levant series, a military product), covering Transjordan west of the Hejaz railway from north (Yarmuq River) to south ('Aqaba). As only very crude maps were available for this area before, this series is an important innovation.

A geological map of Palestine north of Beersheba on the 1:250,000 scale was produced by the late G. S. Blake before the war. The southern sheets are in course of publication now. And I understand that 1:100,000 cover is available for the whole country, but its publication is not yet intended, for financial reasons. An instructive population map, on the disk method, compiled by Dr. E. C. Willatts, on the staff of the Anglo-American Committee of Inquiry, was published in the appendix of five maps to that committee's report.

Another map I should mention is a revised edition of the bathymetric map of Lake of Tiberias, 1:115,000, with contours at 5 m. interval, published by Dr. Ashbel, accompanying his paper on the temperatures of the fresh-water lakes of Palestine (*Ha-Teva*, [*Nature*], Vol. 2, 1945, pp. 72–79).

The war was a period of consolidation for the agricultural population of Palestine, as in all countries which did not have to bear the direct brunt of the war. Most of the farmers, both Jews and Arabs, liquidated their debts, and some of them accumulated cash balances to an extent they had never known before. This applies more particularly to the Arabs, since Jewish farmers had to liquidate debts of more recent investments and reinvested surpluses as they became available.

"Mixed farming" is the general principle in Palestine now. The citrus industry suffered severely during the war through the inability to export. Some of the groves were properly cared for with the help of Government grants, others deteriorated completely.

There are three interesting new lines in Jewish agriculture:

Introduction of fish breeding started shortly before the war when both methods and fish were brought from Yugoslavia. Today fishponds are a common feature in many cooperative settlements: they give a new aspect to the landscape and produce large quantities of high-quality fish.

Many cooperative settlements, and especially the larger ones, have established workshops and factories in addition to their agricultural activities—canneries, factories for engine tools, furniture, machinery, etc., and establishments for the recreational industry. These are a source of additional cash income and absorb surplus manpower during agricultural slack periods.

Progress has been made with the long-distance provision of irrigation water at reasonable prices. This is being done by rational concentration of available water and new drillings and by distribution through overland pipe-line systems by the Meqoroth Co. Ltd. Consequently, intensive farming is possible now in vast areas hitherto under extensive cultivation.

In the field of Jewish settlement important progress has been made. More than 80 new settlements have been established since the outbreak of the war in all parts of the country. Special mention must be made of two areas: the upper Hule Basin and the Negeb. The Hule Basin was noted both for its 100% incidence of endemic malaria and for its fertile, heavy soils. Malaria has been extinguished by over-all application of DDT through Army and Government agencies. And the dozen young Jewish settlements doing valuable reclamation work there are as flourishing and healthy as any others in the country.

The Negeb is a true frontier area, and it is here that the most important pioneer effort

of modern Palestine is being made. Three years ago three experimental settlements were established in different parts of the Negeb by the Jewish Agency. Experiments with various kinds of crops and different types of cultivation, and also investigations of water resources and their development and meteorological observations, were carried out at these places. The preliminary results of these investigations have been summarized in a recent paper by Joseph Weitz, "Report from the Negeb" (*Palestine and Middle East,* Tel Aviv, Oct., 1946). The experiments showed the general suitability of most types of crops for remunerative cultivation in this area if a certain amount of water is available. This result is most important considering the recent large-scale development plans outlined by Lowdermilk. Under this scheme considerable quantities of irrigation water would be supplied to the Negeb from northern Palestine, both from the Jordan River and from springs, and from reservoirs in the Hebron hills, which combine nearness to the Negeb with an abundance of suitable sites and an annual rainfall of 16–32 inches. Initially various small-scale approaches were made to the problem of water supply, including an experiment in the damming of floodwater. A second stage is now entered on with the construction by the Jewish colonisation authorities of a long-distance pipe line for the supply of irrigation water to the Negeb settlements and neighbouring Arab consumers. This line starts in the Southern Coastal Plain, where ample underground water is available. Mr. Weitz estimates (First Steps in the Negeb, *Palestine and Middle East,* February, 1947) that "15 million cubic metres of water could be at once supplied in this way, a quantity sufficient to irrigate some 30,000 dunams, or 1500 intensely cultivated farming units of 20 dunams each." (Four dunams equal approximately one acre.)

Recently, based on the experiences at the three experimental sites, new villages have been established in the northern and central parts of the Negeb, making a total of 17 and thus bringing it once again into the area of settled habitation. Before this the Negeb was for hundreds of years inhabited only by Bedouins. Even the small town of Beersheba, the only permanently inhabited site until a short while ago, was not established by the Turks until the end of the last century.

Even ten years before this new step in Jewish colonisation was taken, the opportunities and dangers of extending cultivation in this frontier had already been demonstrated. Government has fostered for many years the development of grain culture in the northern Negeb. The commonest form this encouragement took was the deep ploughing and, in part, harvesting of most of the area by Government-owned agricultural machinery. These lands are owned by Arabs, mostly large landowners and tribal sheikhs. Much of the area came under cultivation, and at an accelerated rate, during the war years. But owing to the ignorance of the cultivators of even primitive soil-conservation measures and the lack of guidance on this subject, soil erosion is spreading dangerously in this area today. Soil erosion is a common evil in Palestine. Large parts of its hill slopes have been stripped of their soils. But nowhere else in the country is the picture duplicated of the extreme badland type of gully erosion one finds in a certain part of the northwestern Negeb. Here it is said that some of the gullies make headway at the rate of one meter per year. But just in this area is being demonstrated what can be done in soil conservation, at the village of Dorot, which was awarded a Government prize for the complete contour layout of all its fields and cultivation terraces.

The guiding principles of Jewish colonisation during these years have been both economic —the establishment of new villages which can absorb more farmer population—and political. It was mainly from political considerations that Jewish settlements were established in parts of Upper Galilee and, particularly, in the Negeb, to stake claims in case of partition.

There is one isolated settlement, established in 1940, which I should mention on account of its special achievements in reclamation. This is Beit ha 'Arava in the Jordan Valley, less than 3 km. from the north shore of the Dead Sea. Beit ha 'Arava (The House in the Steppe) stands on the thoroughly saline soils of the "Lisan marls." These saline soils had always been considered definitely sterile and unsuited to any kind of cultivation; however, by washing them for some months with large amounts of Jordan water the injurious minerals were removed from the topsoil or precipitated into the lower marl layers, and for the last few years high-class agriculture has been carried on at Beit ha 'Arava. It is particularly famous for its succulent vegetables. The warm, subtropical climate of the Lower Jordan Valley enables the farmers of Beit ha 'Arava to harvest their products the year round and market them at times when no other producers can supply them. This opens up prospects of reclamation, though at a high initial cost, for a large area in the Jordan Valley classified hitherto as absolute waste.

The next point I have to mention is a negative one. Palestine has had so far two censuses of population, in October, 1922, and in November, 1931. At this last census a total population of 1,035,821 was enumerated. The next census was scheduled for October, 1941, but was cancelled because of the war. So was a census which had been planned for October, 1946, since Government refused to agree to the basic condition for the cooperation of the Jewish population, i.e. legalization of the so-called "illegal" residents. The official estimate of the population of Palestine today is 1,800,000, but it is an estimate, and correct figures with all the details are badly needed now, after the 15 years that have elapsed since the last census.

I conclude with some figures about the meteorological network of the country:

We have 30 meteorological stations. One of them makes hourly observations, 6 three-hourly observations, and the rest three observations per day. There are about 500 rainfall stations in Palestine, and about 50 in Transjordan. The rainfall network has been considerably extended during recent years, and by opening stations in many Arab village schools it has been possible to close the station gaps in the hill country. The most recent additions to the rainfall network are 25 stations at Bedouin tribal schools in the Negeb, which together with stations at the new Jewish settlements make the northern part of the Negeb today better equipped with rainfall stations than certain other parts of Palestine.

Dew observations are undertaken at about 60 stations. Shortly before the war S. Duvdevani, instructor at an agricultural school, developed a simple, and therefore generally applicable, method for dew observation. A standard painted wood surface is exposed during the night at standard heights (30 and 100 cm.). At sunrise the observer compares the appearance of the dewdrops on the dew gauge—density, size, and coagulation—with specimen photographs in a small dew atlas and thereby defines the dew of the night as one in a scale of ten. Duvdevani evaluated the water equivalents of the ten dew grades, so that the figures reported by the observers can be converted into millimetres of precipitation. The results are very interesting, and of particular importance for the arid south of Palestine. Beyond this they have general practical application for the selection of particular plants in a country with dry summers, such as Palestine. The method has been recommended to the conference of Empire meteorologists for introduction in all arid countries.

Yours very sincerely,

D. H. Kallner

EMPIRICAL MATHEMATICAL RULES CONCERNING THE DISTRIBUTION AND EQUILIBRIUM OF POPULATION*

JOHN Q. STEWART

THERE was a time when scholars did not realize that number had the principal role in the description of the phenomena of physics. The transition from medieval to modern science was made in celestial mechanics, in three stages. These can be concisely represented by Tycho Brahe's extensive observations of planetary motions, Kepler's faith in mathematics as a means of insight into phenomena, and Newton's progress from Kepler's empirical rules for the solar system to the mechanics of the entire universe.

We are now seeing a similar development in the social studies. Astonishing amounts of significant numerical data have been accumulated by conscientious social statisticians. Publications of the Bureau of the Census, for example, are comparable in extent and variety with catalogues of stars or tables of spectroscopic wave lengths, even if the numerical precision necessarily is much less. Thus the observational stage is well advanced. A few investigators whose training is not confined to the social fields are beginning to proceed with the condensation of the voluminous sociological data into concise mathematical rules. The final rational interpretation of such empirical rules cannot come until after the rules themselves are established.

The way of progress is obstructed by the opinion, common among authorities on economics, politics, and sociology, that human relationships never will be described in mathematical terms. There may be some truth in this as regards the doings of individual persons. Even the physicist has given up the idea that the behavior of individual particles can be precisely described thus and necessarily contents himself with discussions of averages. But the time to emphasize individual deviations is after the general averages have been established, not before.

Demography, the study of populations, offers an especially favorable field for the study of averages of social behavior. This paper presents four empirical rules relating to populations and their mutual influences. Two of these have been stated by the writer previously, the third has been pub-

*Thanks must be expressed to Dr. Kingsley Davis for tabulations of data from censuses of India and to Dr. Irene B. Taeuber for data on Japan, to the Princeton University Observatory, and to the Institute for Advanced Study and Miss Catherine Kennelly.

lished by others; new supporting evidence and development of these three are given, and a fourth rule is presented for the first time.

The Rank-Size Rule for Cities

Professor George Kingsley Zipf of Harvard University described with much emphasis in a book published half a dozen years ago[1] the rank-size rule for cities. The original statement was by Auerbach,[2] but Zipf gave it far more attention. The rule applies to certain groups of cities and is

$$R^n S_R \doteq M. \tag{1}$$

Here M and n are constants for the given group, S_R stands for the number of people who live in the Rth city in the group, and R is the rank in the group of that city. The rank is a city's order number in a list that runs consecutively from the largest city in the given group to the smallest one. Thus for cities of the United States in 1940 we have the following ranks, R: New York, 1; Chicago, 2; Philadelphia, 3; .....; Utica, 92; .....; Sharon, Pa., 401; and so on. There were 3464 cities and towns greater in size than 2500; smaller villages are classed by the United States census as "rural."

The rank so defined is necessarily a positive integer. When R is 1, equation 1, whatever the value of n, requires that S is then M; hence the constant M is equal to the size of the largest city in the group. However, since the rule holds only to a statistical approximation and is not rigorous, a better average fit in practice may be obtained by an adjustment of M to a value that is not exactly equal to the size of the largest city. The value of 8,660,000 in 1940 fitted the average run of United States city sizes better than New York's actual size of 7,454,995.

Throughout this paper we must guard, on the one hand, against giving the impression that any one of the empirical rules presented is at all exact and, on the other, against suggesting that the approximations are so rough as to be without profound interest and meaning. If we divide 8,660,000 by 401, the population indicated for Sharon, Pa., comes out 21,600, as compared with its actual 25,622. As another illustration, the population of Indianapolis was 386,972, which, divided into 8,660,000, would correspond to a rank of 22, whereas the actual rank of Indianapolis in 1940 was 20.

If there are C cities of sizes not less than a certain lower limit, S_C—the size of the city of rank C being S_C—equation 1 requires:

$$C^n S_C = M = S_1, \tag{2}$$

[1] G. K. Zipf: National Unity and Disunity, Bloomington, Ind., 1941.

[2] Felix Auerbach: Das Gesetz der Bevölkerungskonzentration, *Petermanns Mitt.*, Vol. 59, 1913, pp. 74–76. See also A. J. Lotka: Elements of Physical Biology, Baltimore, 1924, pp. 306–307; the same: The Law of Urban Concentration, *Science*, Vol. 94 (N.S.), 1941, p. 164.

the size of the largest city being S_1 or M. In 1940 there were 3464 cities larger than 2500 population; the product of 3464 x 2500 is the 8,660,000 already mentioned as the adjusted value of M in 1940.

It is obvious that, when we assign a numerical value to any S, a difficulty which will often arise is that the usual census figure is for the "political" city, whose people live within the somewhat arbitrary "city limits."[3] The "physical" city, a single urban concentration that presumably functions as a single whole, may be considerably larger than the political city. This is not a fundamental difficulty, but one of refinement merely; it is worth special study, which can be postponed.

If an arbitrary group of cities is selected—for example, the largest city in one state, the second largest in another, and so on—equation 1 will not be found to hold. It does not hold for the cities of Great Britain, unless they are considered with all other European cities. But it is a fact that when all the cities in the United States larger than 2500 (or than some lower limit greater than 2500) are examined in any one of the 16 censuses 1790–1940, equation 1 holds approximately, and always with n equal to 1, or nearly 1. For each census, M, as expressed in equation 2 with $n = 1$, is found to approximate the size of New York City at that census.[4] Since the number of cities above 2500 increased from 24 in 1790 to 3464 in 1940, this is a very large range of agreement. It at once establishes the rank-size rule as an important empirical relation, with the presumption that it is the result of major underlying demographic tendencies.

Readers whose training has been verbal rather than mathematical may be impatient to be told at once what the underlying reasons are for the rank-size rule and what applications it has to immediately practical problems. These are reasonable inquiries, but their answers can only come in due course, and such readers will be blind to the lessons of physical science if they lose patience and interest when it is confessed that full answers cannot yet be provided.

The total population of a number of cities of consecutive ranks has a formula easily derived from the rank-size rule. The value of n in (1) may be between 0 and 1, 1, or more than 1. Since by definition the largest city has rank 1, it is clear that n must not be negative. Three excellent approximations to the exact sum can be written for these three cases.

Let P_u stand for the total population of the largest R cities. Evidently,

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[3] J. K. Wright: Certain Changes in Population Distribution in the United States, *Geogr. Rev.*, Vol. 31, 1941, pp. 488–490.

[4] As tabulated in Sixteenth Census of the United States, 1940: Population, Vol. 1, Number of Inhabitants, Table 12 (pp. 32–33), which totals the people who lived in what now are the five boroughs.

since the city of rank 1 is expected to have size M, that of rank 2 has the size $M/2^n$, that of rank 3, $M/3^n$, and so on, if the rank-size rule holds. Hence

$$P_u = M\,(1 + 1/2^n + 1/3^n + \dots + 1/R^n). \tag{3}$$

For a given value of n, the series in the parentheses can always be summed by direct computation; but when R is in the hundreds or thousands, that is extremely laborious. When R is not too small, direct summation is unnecessary, because the following approximate formulas can be established:

When n is between 0 and 1:

$$P_u = M\left(\frac{R^{1-n}}{1-n} + \frac{1}{2R^n} + K_n\right). \tag{4}$$

When n is 1:

$$P_u = M\left(\log_e R + \frac{1}{2R} + K_1\right). \tag{5}$$

When n exceeds 1:

$$P_u = M\left(\frac{1}{2R^n} - \frac{1}{(n-1)R^{n-1}} + K_n\right). \tag{6}$$

In each case K_n is a special constant: its value depends only on n and not on R. The term $1/2R^n$ becomes unimportant as R increases. The series in the parentheses of (3) has received much study from mathematicians. Equations 4, 5, and 6 are simplifications of an exact formula, which has the form of an infinite series in descending terms of R.[5]

In order to use these equations for total urban populations, it is necessary to have the proper numerical values of K_n. These are tabulated in Table I, for a practical range of values of n.

We see that P_u, the sum of the populations of the R largest cities, is determined as a function of the size, S_R, of the Rth city, provided n is known. Note that when n exceeds 1, P_u approaches a finite limit, namely MK_n, as R gets larger and larger. When n is 1 or less, P_u grows without limit as R increases—provided the rank-size rule holds all the way.

The best determination from census data of M and n for a particular group of cities is made by the well-known statistical method of "least squares." This is time-consuming, and for the purposes of the present survey adequate solutions have been obtained by trial and error, or by graphing. When logarithms are taken, (1) becomes

$$\log S_R = \log M - n \log R.$$

Consequently, when values of S_R are plotted to a logarithmic scale as ordinates, against corresponding values of R as abscissas, for an actual group

[5] See J. W. L. Glaisher: The Constants That Occur in Certain Summations by Bernoulli's Series, *Proc. London Math. Soc.*, Vol. 4, 1871, pp. 48–56.

of cities approximately obeying the rank-size rule, the plotted points scatter somewhat but nevertheless define *a straight line* that slopes downward from left to right. Its negative slope is n, and its intersection with the axis of S when R is 1 fixes log M.

TABLE I—VALUES OF K_n (EQUATIONS 4, 5, 6)

n	K_n	n	K_n	n	K_n
0.1	−0.60	1/4	−0.81	10/9	+9.58
0.2	−0.73	1/3	−0.97	9/8	+8.59
0.3	−0.90	1/2	−1.46	8/7	+7.59
0.4	−1.14	2/3	−2.45	7/6	+6.59
0.5	−1.46	5/7	−2.95	6/5	+5.59
0.6	−1.96	3/4	−3.45	5/4	+4.60
0.7	−2.78	10/13	−3.78	4/3	+3.60
0.8	−4.44	4/5	−4.44	3/2	+2.61
0.9	−9.42	5/6	−5.44	7/4	+1.96
1.0	+0.58	6/7	−6.43	2	+1.64

NOTE.—Values not listed by Glaisher (*loc. cit.*) were computed by applying the Euler-Maclaurin formula (cf. E. T. Whittaker and G. Robinson: The Calculus of Observations, London 1924, p. 138). The variation of K_n with n, except near $n = 1$, is regular and smooth, and can be interpolated graphically between the above values. For $n = 3$, $K_n = +1.20$.

Tables II and III present observational confirmation of the applicability of the rank-size rule and its corollaries for cities of the United States over a period of many censuses, and for the 601 cities of the world that in the 1930's were listed as larger than 100,000. The respective values of n are 1 and 10/13, but least-square solutions would show some tolerance in each estimate.

United States census data are not complete for the villages. These, unless incorporated, are lumped indistinguishably with their farm neighbors in each minor civil division. Therefore it is not possible to give the lower limit of size, above which the rank-size rule holds. If it held down to individual persons, the rank of the "final community" of one person always would be M; compare equation 2. If we ignore the difficulty of having communities comprised of whole people plus a fractional person, equation 5 would require that the population of all the M communities—i. e. the total population of the United States—should be

$$P_T = M\ (\log_e M + 0.58). \tag{7}$$

In each census before 1930 substitution of the observed value of M gives too small a value of the total population—much too small in earlier days. Therefore equation 7 is inapplicable. This matter has been discussed by Zipf, in his second chapter, in a speculative way.

When in (7) the value $S_C C$ is substituted for M, and S_C is taken as 2500

TABLE II—THE INVARIANT POPULATION PATTERN OF THE UNITED STATES

C = number of cities of sizes >2500 $\qquad$ $(C) = 1 + 1/2 + 1/3 + 1/4 + \ldots \log_e C = \ln C + 0.58$

U = urban fraction = P_U/P_T $\qquad$ M = population of largest city = 2500 C

P_U = urban population, which the census reports as the sum of the populations of the cities

P_T = total population $\qquad$ P_R = rural population (towns <2500 and country districts)

			Computed values					Observed values				
Census	C	$f(C)$	U	log M	log P_U	log P_R	log P_T	U	log M	log P_U	log P_R	log P_T
1790	24	3.76	4.8	4.78	5.35	6.65	6.67	5.1	4.69	5.36	6.57	6.59
1800	33	4.07	5.6	4.92	5.53	6.75	6.78	6.1	4.90	5.51	6.70	6.72
1810	46	4.41	6.6	5.06	5.71	6.85	6.88	7.3	5.08	5.72	6.83	6.86
1820	61	4.69	7.6	5.18	5.85	6.95	6.97	7.2	5.18	5.84	6.95	6.98
1830	90	5.08	9.3	5.35	6.06	7.05	7.09	8.8	5.38	6.05	7.07	7.11
1840	131	5.45	11.2	5.52	6.25	7.15	7.20	10.8	5.59	6.27	7.18	7.23
1850	236	6.04	15.0	5.77	6.55	7.31	7.38	15.3	5.85	6.55	7.29	7.37
1860	392	6.55	19.4	5.99	6.81	7.43	7.52	19.8	6.07	6.79	7.40	7.50
1870	663	7.07	25.2	6.22	7.07	7.54	7.67	25.7	6.17	7.00	7.46	7.59
1880	939	7.42	30.0	6.37	7.24	7.61	7.77	28.2	6.28	7.15	7.56	7.70
1890	1348	7.78	35.9	6.53	7.42	7.67	7.86	35.1	6.40	7.34	7.61	7.80
1900	1737	8.04	40.8	6.64	7.54	7.71	7.93	39.7	6.54	7.48	7.66	7.88
1910	2262	8.30	46.5	6.75	7.67	7.73	8.01	45.7	6.68	7.62	7.70	7.96
1920	2732	8.49	51.1	6.84	7.76	7.75	8.06	51.2	6.75	7.73	7.71	8.03
1930	3165	8.65	55.0	6.90	7.84	7.75	8.10	56.2	6.84	7.84	7.73	8.09
1940	3464	8.73	57.6	6.94	7.88	7.75	8.12	56.5	6.87	7.87	7.76	8.12

TABLE IIIA—LEADING CITIES OF THE WORLD

Rank R	Size S	log M	Rank R	Size S	log M
1	8,655,000	....	52	790,398	7.218
2	7,154,300	7.168	66	662,000	7.221
3	5,875,667	7.136	83	570,622	7.233
4	4,251,000	7.091	104	489,488	7.241
5	3,641,500	7.099	130	386,900	7.213
7	3,489,998	7.193	163	310,118	7.193
0	2,739,800	7.207	204	261,226	7.193
2	1,972,700	7.125	257	211,000	7.177
5	1,666,100	7.126	323	173,573	7.167
8	1,354,100	7.097	406	140,500	7.155
2	1,257,890	7.131	510	116,687	7.228
7	1,148,129	7.160	601	100,000	7.137
4	1,029,700	7.189			
2	910,154	7.207		Average	7.172

NOTE.—A card index of all 601 cities was prepared, each card eing marked with the size and corresponding rank of a city. In is illustrative table examples are chosen at random scattered over e whole range of ranks. In the third column values of log M re computed from the assumed formula $M = R^{0.769}\,S$. These f course scatter somewhat about their average, 7.172—which orresponds to M = 14,860,000. London is not nearly big enough fill rank 1. (The size of New York is from the same compilation s the others and is less than in the 1940 census.)

TABLE IIIB—THE WORLD'S LARGEST CITIES

Rank R	City	Computed size S	Actual size
1	London	14,900,000	8,655,000
2	New York	8,710,000	7,154,300
3	Tokyo	6,380,000	5,875,667
4	Berlin	5,120,000	4,251,000
5	Moscow	4,310,000	3,641,500
6	Chicago	3,750,000	3,397,700
7	Shanghai	3,330,000	3,490,000
8	Osaka	3,010,000	2,990,000
9	Paris	2,740,000	2,830,000
10	Leningrad	2,530,000	2,740,000
—			
48	St. Louis	747,000	830,000
—			
125	Kansas City, Mo.	339,600	412,600
—			
473	Trenton, N. J.	130,000	124,000

NOTE.—From the formula $S = M/R^{0.769}$, with M = 14,860,000, values of S are computed for the first ten ranks and certain others. London does not fit the formula. But for New York to move into rank 1 would require an increase of 75% not only in its size but in the size of other American cities, since these are subject also to their own rank-size rule with exponent 1. The sum of the computed populations of the nine cities of ranks 2–10 inclusive is 39,880,000. This compares well with the sum from equation 4, with n = 0.769, and K_n = −3.78; namely 39,800,000.

(the rural limit), we obtain, if we write P_U for the population of the cities—the total urban population—

$$P_T = P_U + M \log_e 2500.$$

This equation, also, does not apply; the observed relation between urban, rural, and total populations is given in (9) and (10) below.

Applicability of the rank-size rule is not confined to city sizes. With $n = 1/2$ it is Pareto's rule for the size of incomes.[6] Condon found that the rule, with $n = 1$, described the frequency of occurrence of words in written English,[7] and Zipf has found that the rule has further applicability to other word counts.[8] Yule's objection[9] to it has no immediate relevance. Lotka[10] found that the rule, with $n = 2$, described the distribution of scientific papers among different authors.

In physics, the Boltzmann distribution of energies among the molecules of a gas in thermodynamic equilibrium offers a general analogy, but only a general one. It seems that the rank-size rule is one which occurs, or at any rate is closely approximated, in a different type of equilibrium among competing elements, which has not yet been recognized in physics, though it occurs in the above-mentioned widely different sociological cases.

A consideration of what factors produce the hypothetical equilibrium will be aided by a comparison of demographic and social conditions that are expressed in different values of the exponent n. Censuses of Japan 1920–1935 indicate a country in transition, because n increased from about 2/3 to 1 for *shi* above 20,000. This contrasts with the stability of n over 150 years in the United States. Sufficient census data are available also for India 1891–1941. The rank-size rule there for cities above 5000 population has $n = 5/7$ approximately, during this entire period.

The author is not familiar with any study which relates the rank-size rule or the potential of population to existing studies dealing with the location of cities[11] and with the degree of concentration of communities.[12]

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[6] Zipf, *op. cit.*, Chap. 5.

[7] E. U. Condon: Statistics of Vocabulary, *Science*, Vol. 67 (N.S.), 1928, p. 300.

[8] See list of references in G. K. Zipf: The Repetition of Words: Time, Perspective, and Semantic Balance, *Journ. of General Psychology*, Vol. 32, 1945, pp. 127–148.

[9] G. U. Yule: The Statistical Study of Literary Vocabulary, Cambridge, England, 1944, p. 55.

[10] A. J. Lotka: The Frequency Distribution of Scientific Productivity, *Journ. Washington Acad. of Sci.*, Vol. 16, 1926, pp. 317–323. This paper includes additional interesting references.

[11] See, for example, Edward Ullman: A Theory of Location for Cities, *Amer. Journ. of Sociology*, Vol. 46, 1940–1941, pp. 853–864, which discusses Walter Christaller's factor of centrality. See also E. M. Hoover, Jr.: Location Theory and the Shoe and Leather Industries, Harvard Univ. Press, 1937; Chaps. 1–6; the same: The Location of Economic Activity (In preparation).

[12] References to the work of Albert Demangeon and others are included in the note "The Geography of Rural Settlements," *Geogr. Rev.*, Vol. 24, 1934, pp. 502–504.

The Relation of the Number of United States Cities and the Urban Fraction

We pass now to a hitherto unpublished empirical relation, which is well established only for one special case. At present writing this new rule is far from having the variety of observational significance that the rank-size rule possesses. As has been said, the United States Bureau of the Census defines a village as "rural" when it has fewer than 2500 people; and of course

Table IV—Relation of Urban Fraction to Number of Cities, United States

Year	Number of Cities C	Urban fraction U Observed	Computed	$\log \frac{C}{10450U^2}$
1790	24	0.051	0.048	−0.055
1800	33	.061	.056	− .070
1810	46	.073	.066	− .082
1820	61	.072	.076	+ .050
1830	90	.088	.093	+ .045
1840	131	.108	.112	+ .032
1850	236	.153	.150	− .016
1860	392	.198	.194	− .020
1870	663	.257	.252	− .017
1880	939	.282	.300	+ .054
1890	1348	.351	.359	+ .017
1900	1737	.397	.408	+ .023
1910	2262	.457	.465	+ .034
1920	2732	.512	.511	+ .005
1930	3165	.562	.550	− .019
1940	3464	.565	.576	+ .017

Note.—Values of U usually are stated in percentages: thus 0.051 corresponds to 5.1%, etc. The last column shows the close agreement of the formula (10) with the facts. The statistical "probable error" in the logarithm (base 10) is ±0.0277, corresponding to a factor of 1.066.

dwellers in the open country are classed as rural. People who live in all larger towns are "urban." This distinction is made in each of the 16 censuses. As everyone knows, the proportion of city dwellers has been consistently increasing in the United States. The number of cities above 2500, which we shall call C, likewise has increased considerably.

The urban fraction, U, is defined as the fraction of the total population, P_T, that lives in cities above 2500. Thus

$$P_U = UP_T, \tag{8}$$

P_U being the total urban population of the C cities. Letting P_R stand for the rural population, we have

$$P_R = P_T - P_U. \tag{9}$$

Table IV shows that the relations

$$C = 10450\ U^2, \tag{10}$$

$$U = 0.009782\sqrt{C}, \tag{11}$$

hold very well, from census to census, 1790–1940.

If the rank-size rule represents an equilibrium among competing cities, this relation of U to C must mean that there is also an equilibrium between the competing attractions of rural and urban life.

Values of U are also available for India, but the range of change in the available censuses is too small to establish equally well relations corresponding to (10) and (11). The evidence is that the exponent of U in the relation corresponding to (10) for India is reduced perhaps to 12/7.

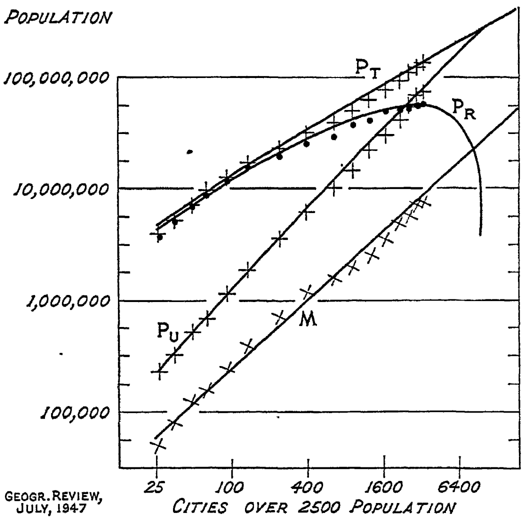

FIG. 1—Structure of the population of the United States (See Table II). Observed values at the 16 censuses are indicated by the crosses and dots; curves or straight lines show the values computed from the observed number of cities, C, of size larger than 2500, as base variable, by equations 12. Up to C = 10,450 the extrapolated curves likewise follow these equations. Any one of five quantities — total population, P_T, urban population, P_U, rural population, P_R, population of largest city, M, and number of cities, C, — could be taken as the *single independent variable.* Additional computed curves, and compatible observations, could be given for selected groups of cities; for example, the number and summed populations of those between sizes 10,000 and 25,000.

THE FUNDAMENTAL STRUCTURE OF UNITED STATES POPULATION

Figure 1 shows how well the simple equations we have developed describe the rural-urban distribution in every United States census. It graphs data of Table II, with extrapolations to the future. The continuous curves represent computed values of the various components of populations; the x's, crosses, or circles represent the actual populations, census by census. The number, C, of cities larger than 2500 is taken as the base variable. In terms of it the following quantities are computed: S_1 or M, the size of the largest city (New York, people living in the present five boroughs); P_U, the total urban population of the C cities; P_T, the total United States population; and P_R, the rural population.

The applicable equations are brought together here for clarity (cf. equations 2, 5, 11, 8, 9). We take $n = 1$, for the United States, and $S_C = 2500$:

$$\left.\begin{aligned} &M = S_C\, C; \\ &P_U = S_C\, C\left(\log_e C + \frac{1}{2C} + 0.577\right); \\ &U = 0.009782\sqrt{C}; \\ &P_T = P_U / U; \\ &P_R = P_T - P_U. \end{aligned}\right\} \qquad (12)$$

Note that Figure 1 has no intrinsic time scale, but only the empirical time scale that successive censuses establish, through the observed values of C from decade to decade. A prediction of future total population was made by Pearl,[13] but he did not break down the population into rural and urban components.

Demographers are now making predictions of populations by extrapolating the birth rate and death rate. The latest such prediction for the United States[14] gave estimates of the total population, P_T, for various years until 2000. If we assume that the equilibrium equations (12) of Figure 1 will continue to hold, these values of P_T establish the corresponding values of C, M, P_U, P_R.

Since the equations indicate that P_R has already reached its maximum value, the expected increase in P_T all goes to an increase in P_U. Briefly, one can say that the outlook is for an increase in urban population for the next 20 or 25 years at the rate of 1 per cent a year of the present urban population. The same prediction applies to every United States city, large or small, that holds its present rank among our cities. Of course, some will make relative gains, others will lose rank.

Figure 1 in itself does not mean that the population will increase rather than decrease. However, if P_T ever becomes 260,000,000, the indication is that the rural population will have disappeared—except, doubtless, for a stubborn remnant that has not yet made its resistance evident in the data. If that time ever comes, all the people will be living in 10,400 cities greater than 2500, and the largest city (still New York?) will have a population of 26,000,000.

If populations should still go on increasing after that highly problematical time, an extrapolation of the above treatment suggests that the larger cities

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[13] Raymond Pearl: Introduction to Medical Biometry and Statistics, 3rd edit., Philadelphia, 1940, Chap. 18.

[14] U. S. Bureau of the Census, Population—Special Reports, Ser. P-46, No. 7, September 15, 1946.

would then begin to eat up the smaller ones, and that finally everyone would live in a single great H. G. Wells city. Its population when that epoch begins works out as 6¼ billions—but these extreme extrapolations had better be regarded as just a little fun with arithmetic.[15]

THE POTENTIAL OF POPULATION

The evident tendency of people to congregate in larger and larger cities represents an attraction of people for people that turns out to have a mathematical as well as a merely verbal resemblance to Newton's law of gravitation. Lagrange in 1773 found that where the attraction of several planets at once was under consideration, a new mathematical coefficient, not used by Newton, simplified the calculations. This coefficient amounted to a measure of the gravitational influence of a planet of mass m at a distance d, and it was as simple as possible, merely m/d.

Later mathematical physicists, Laplace and Poisson, further elaborated the m/d concept in celestial mechanics. Not until 1828 did Green find that similar measures existed of the influence of an electric charge, e, and of a magnet pole, p, at a distance d; namely e/d and p/d respectively. To these quantities the name "potentials" was given—the gravitational potential, the electrostatic potential, the magnetic potential.

In 1939 evidence was uncovered which suggested that the influence of people at a distance could be expressed by a similar coefficient, namely N/d —N being the number of people, and d their distance away.[16] For this coefficient the name "potential of population" was at once suggested, because of the physical analogies.

As examples of "influence" reference may be made to:[17] (1) the drawing power of a college or school on given communities or states (enrollment in seasoned, privately endowed, "national" institutions tends to be proportionate to the population of a state divided by its distance from the campus); (2) attendance at the New York World's Fair in 1940 by states (proportionate to the population of a state divided by its distance from Flushing, Long

[15] The last time the author used in print the expression "fun with arithmetic" was in connection with extravagant illustrations of the enormous size of the constitutional energy of matter—illustrations that have been widely reproduced since August 6, 1945, in popular explanations of nuclear fission (The Search for the Source of Stellar Energy, *Journ. Franklin Inst.*, Vol. 204, 1927, p. 464).

[16] J. Q. Stewart: The Gravity of the Princeton Family, *Princeton Alumni Weekly*, Vol. 40, 1940, pp. 409–410; *idem:* An Inverse Distance Variation for Certain Social Influences, *Science*, Vol. 93 (N.S.), 1941, pp. 89–90; *idem:* A Measure of the Influence of Population at a Distance, *Sociometry*, Vol. 5, 1942, pp. 63–71.

[17] Cf. J. Q. Stewart: Coasts, Waves, and Weather for Navigators, Boston, New York, etc., 1945, Chap. 11.

Island); (3) circulation of the *St. Louis Star-Times* by counties (copies sold varied according to county population divided by distance from the city).

In each of these three cases the population-divided-by-distance rule held only to a certain boundary. The colleges and schools examined included Princeton, Yale, Harvard, Massachusetts Institute of Technology, Vassar, Stanford, Exeter, and Lawrenceville—all of them seasoned, privately endowed, "national" institutions. For all the eastern ones there was a systematic tendency for enrollment to include two or three times more students from the Rocky Mountain States and, particularly, from the West Coast States, than the formula indicated. The same tendency applied to attendance at the World's Fair. But Princeton undergraduates included roughly 10 times fewer Canadians and 25 times fewer Mexicans than the formula required. As regards the circulation of the St. Louis newspaper, it was found to be confined to a territory in adjoining states that was rather sharply limited by the Kansas City, Chicago, and Memphis competitions.

Again, the World's Fair "pulled" so strongly at a distance of hundreds of miles that extrapolation close at hand in accordance with the inverse-distance rule was obviously absurd. Likewise, the *Star-Times* sold so many copies at a moderate distance that extrapolation of the rule into the city of St. Louis itself led to the impossible requirement that everyone there ought to have bought several copies apiece. Any college draws at any distance so few students per 100,000 of the population that a similar "saturation" effect does not occur close to the campus. Also, college competition, unlike that of most newspapers, is not of the "all or none" type: Yale draws students who live within a mile of Nassau Hall.

Dr. Kingsley Davis, in a recent discussion,[18] made the interesting and logical general suggestion that the "demographic influence" of population N at a distance d is always N/d, but that its realization in various types of "social influence" is subject to special considerations in individual cases.

Further examples of such "social influences" related to potential of population have been furnished by Professor Zipf. These include such surprising agreements as the expectation of the occurrence of obituaries from specified cities in the *New York Times* and of news items in inside pages of the *Chicago Tribune;*[19] also the number of bus passengers between specified cities; the number of telegrams and of telephone messages interchanged; the number of railroad tickets sold.[20]

[18] Kingsley Davis: The Development of the City in Society, First Conference on Long Term Social Trends, Auspices of Social Science Research Council, March 22, 1947.

[19] G. K. Zipf, *Amer. Journ. of Psychol.*, Vol. 59, 1946, pp. 401–421.

[20] Zipf, *Amer. Journ. of Psychol., loc. cit.; idem, Journ. of Psychology,* Vol. 22, 1946, pp. 3–8; etc.

"Energy of Interchange"

In the physical analogies, the potential is the energy in the field (gravitational, electrical, or magnetic) of a unit mass (or charge or pole). The energy of any given mass at a point is the potential at that point multiplied by the said mass. Likewise, we may consider that the "demographic energy" or "interchange" between a population N_1 and a second population N_2 at distance d is N_1 times N_2/d. This demographic energy is the same whether it is computed at the first or the second population, since N_1/d times N_2 equals N_1 times N_2/d.

The data for college undergraduates, when we come to consider them in this way, appear as one example of such "interchange," proportionate to N_1N_2/d, because doubling the size of the student body (without eclectic selection) would be expected ultimately to double the number of students from each state.

It may be asserted with confidence that N_1N_2/d, like potential, is a very important demographic quantity. The evolution of our civilization has been in the direction of increasing it.

Maps of Potential of Population

Density of population is a familiar demographic index—so familiar that we forget its wholly *physical* nature. In order to determine the potential at any point in the United States produced by all the people, it is necessary to start with what amounts to a rather complete survey of the population densities. However, if a very detailed, or "fine-grained," map of potentials is not required, it is enough to have the populations of individual states or larger districts.

On a density map each person—or, more usually, a given number of persons—may be represented by a dot.[21] Such a map shows where people live, but does not show how strongly their influence extends from that place.

Instead of representing a person by a dot, think of each as surrounded by a great sand pile.[22] Suppose that the sand is piled in a ring with a one-mile radius about the individual's residence to some arbitrary height, such as a foot. Then suppose that wider rings are piled, the height decreasing pro-

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[21] See, for example, the Sixteenth Census of the United States, 1940: Population, Vol. 1, p. 2. For a series of density maps of the United States 1790–1930 see C. O. Paullin: Atlas of the Historical Geography of the United States, edited by J. K. Wright, Carnegie Institution of Washington and American Geographical Society, *Carnegie Instn. Publ. No. 401,* 1932, Plates 76–79.

[22] This description of the "sand-pile citizen" is adapted from Stewart, Coasts, Waves, and Weather. *loc. cit.*

portionally as the radius increases, so that in the two-mile ring the sand is 0.5 foot high and in the 1000-mile ring it is only 0.001 foot high. Then the height of his hypothetical sand pile anywhere in the country symbolizes the person's "demographic influence" there, on the basis of the assumed inverse-distance rule.

Suppose that there is a similarly constructed sand pile around the place of residence of every individual in the country. Then suppose that all this sand is superposed. At any point the total height of the sand will be the sum of all the heights of the sand piles of the individuals at that point. Let a contour map be made of the elevations of the resultant terrain.

Where the influence of people sums up to large values, we have "highlands" and "peaks" of influence. Such points are nearer to more people, and all kinds of sociological activities are expected to be at a high level there. Where few people are near, there are "lowlands" of influence—areas that appeal to hermits.

Every city is a separate peak. Each city peak rises from the general level that holds throughout the rural districts around that particular city. The rural districts immediately surrounding New York City are already at the highest level of all the nonurban regions in the country, and from this high platform the "New York peak" rises to the maximum.

The reader will understand that we are speaking only in general terms and that the computed demographic potential is not always effective as a visible sociological factor. Thus the Ramapo Mountains in New Jersey are only 30 miles from New York City, but the "New York Walk Book"[23] says of conditions there: "Most of the farms of the early settlers have reverted to forest, and of these several occur along the Cannonball Road. None of the houses are left, but apple trees remain to mark their place."

Evidently the summed-up value, at any point in the country, of all the individual sand piles is the total potential of population at that point. The physiographic contour map just described is exactly equivalent to a map of potential of population. Along each contour the potential is constant.

Thus we see that a potential map results when a density map is smoothed in accordance with the inverse-distance formula. The original density map cannot be reconstructed from the potential map. Each type of map has its special advantage and use; the two are supplementary, not mutually exclusive. Each concept is a *physical* one.

Figures 3 to 15 present a number of geographical maps, all of which

[23] R. H. Torrey, Frank Place, Jr., and R. L. Dickinson: New York Walk Book, *Amer. Geogr. Soc Outing Ser. No. 2*, 1923, pocket edit., p. 90.

except the one of Europe (Fig. 4) were computed by the writer and his students.[24]

The Construction of Potential Maps

The general procedure in constructing contours of equipotentials of population may be clarified by consideration of a special case (Fig. 2), in

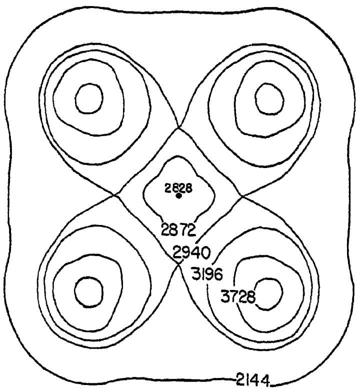


FIG. 2—Equipotentials surrounding four equal charges at the corners of a square. The four equal charges (populations, masses, magnetic poles), if actually concentrated at points would give rise to infinite potentials at these points; but this never happens: each charge always is diffused over a finite space, however small. At a distance (outside the diagram) the equipotentials are nearly circular. The "mountain" rises, with four ridges and four ravines, to the level 2940. Above that it breaks into four peaks, each rising above 3728. A central crater falls to a level of 2828. These values of potential are each proportional to the sum of the four reciprocals of respective distances to the four corners.

which we have a very simple situation on the original density map, namely four equal concentrations. The contours of Figure 2 were constructed as follows: The symmetry of the situation reduces the problem to one of drawing the contours for a single quarter—indeed, for half of this. A number of points over the general area of one octant were selected. For each point the four distances were measured to the four corners of the square and tabulated in four columns. Since the four concentrations were supposed to be equal, summation of the four reciprocals of the distances gave the total potential at each point. (Of course, a constant multiplying factor could have been applied, the same at every point, to allow for any assumed size of the equal concentrations of population at the four corners of the square.)

After such potentials had been determined by measurement and computation for a number of different selected points, the equipotentials shown in the diagram were sketched within the octant by interpolation. In a situation such as this, labor is saved by the shrewd selection of which contours should be drawn first, because often there are certain contours that serve as general controls. Then over the entire area of the square the contours were sketched by symmetry.

In actual demographical cases the population is spread out over wide areas, and it is always necessary to begin with an approximation. The whole

[24] See the reference in Stewart, Coasts, Waves, and Weather, *loc. cit.*

area is divided into a number of districts. On the map of the United States (Fig. 3) 24 such districts were selected, larger in area in the thinly peopled West than in the densely settled East. Each district comprised one full state or more, so that the population could conveniently be taken from census data. The population of each district was arbitrarily supposed to be concentrated at some chosen point within it. Distances in miles were measured

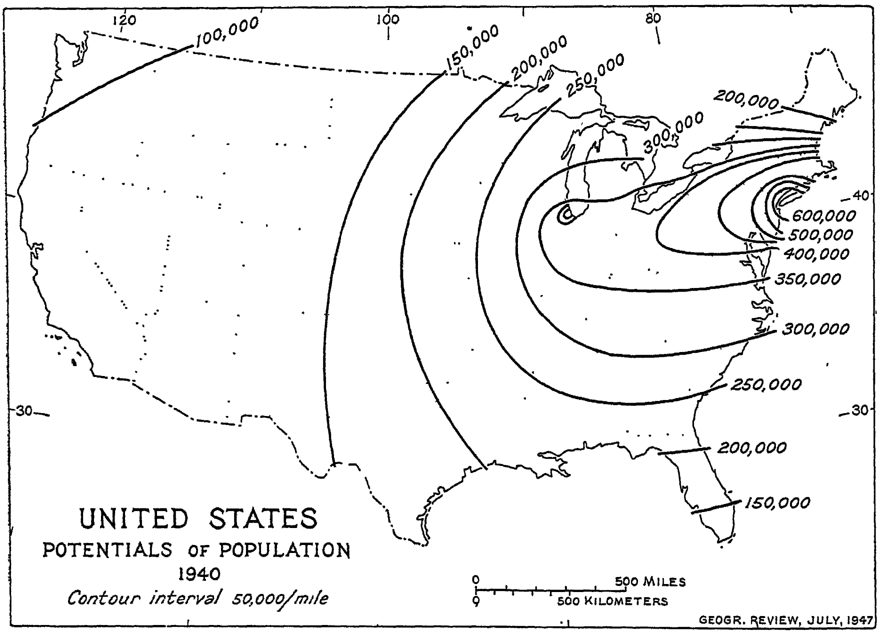


FIG. 3—Contours of the "potentials of population" for the United States, 1940. The potential is a measure of the propinquity of people. Each individual contributes to the total potential at any place an amount equal to the reciprocal of his distance away; contours therefore are in units of "persons per mile." Potential as a sociological influence exerts an effect measurable in many ways. For example, along any one of these contours of equipotential, the density of rural population tends to a constant value, observed to be proportional to the square of the potential. The reader is warned again that none of the maps are precise; in particular the actual contours near large cities differ in that every city presents a separate peak of potential.

on a United States map between the 24 x 23/2, or 276, pairs of districts. Each distance was recorded in its appropriate box in a square diagram having 24 rows and 24 columns. The population of each district was recorded at the head of its column. Also, the name of each district was written alongside one particular row. Down every column the population of the corresponding district was divided by the distance between it and the district represented by each row. The resultant quotient was entered in its appropriate box, corresponding to row and column, and was the potential produced by one district (column) at the other (row). When these partial potentials were

summed along a row, the result was the potential at the district (corresponding to the row) that was produced by all the other districts.

To this had to be added the potential of the district "on itself." If there are many districts, each is small enough to make this contribution to the total potential relatively minor, so that precision in its computation is not very important.

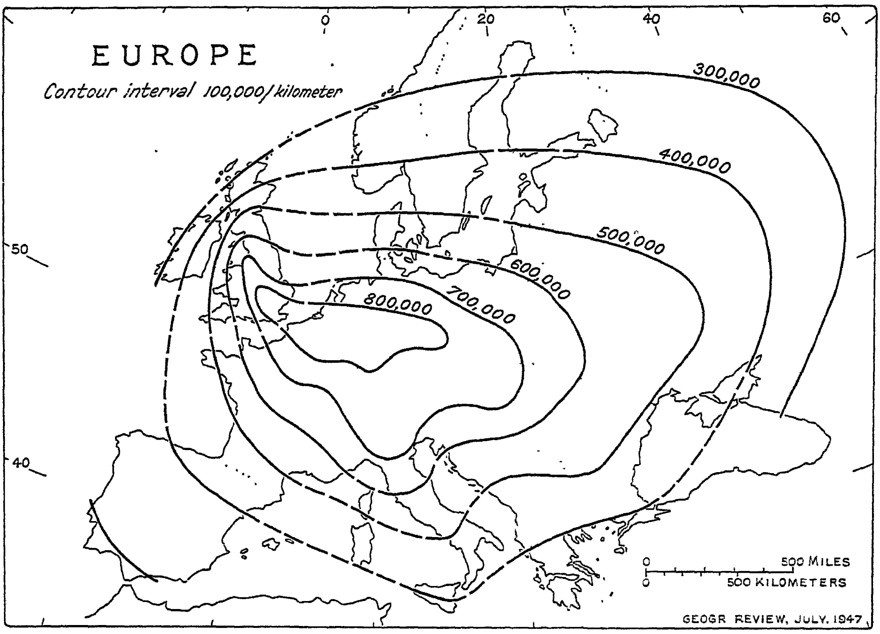
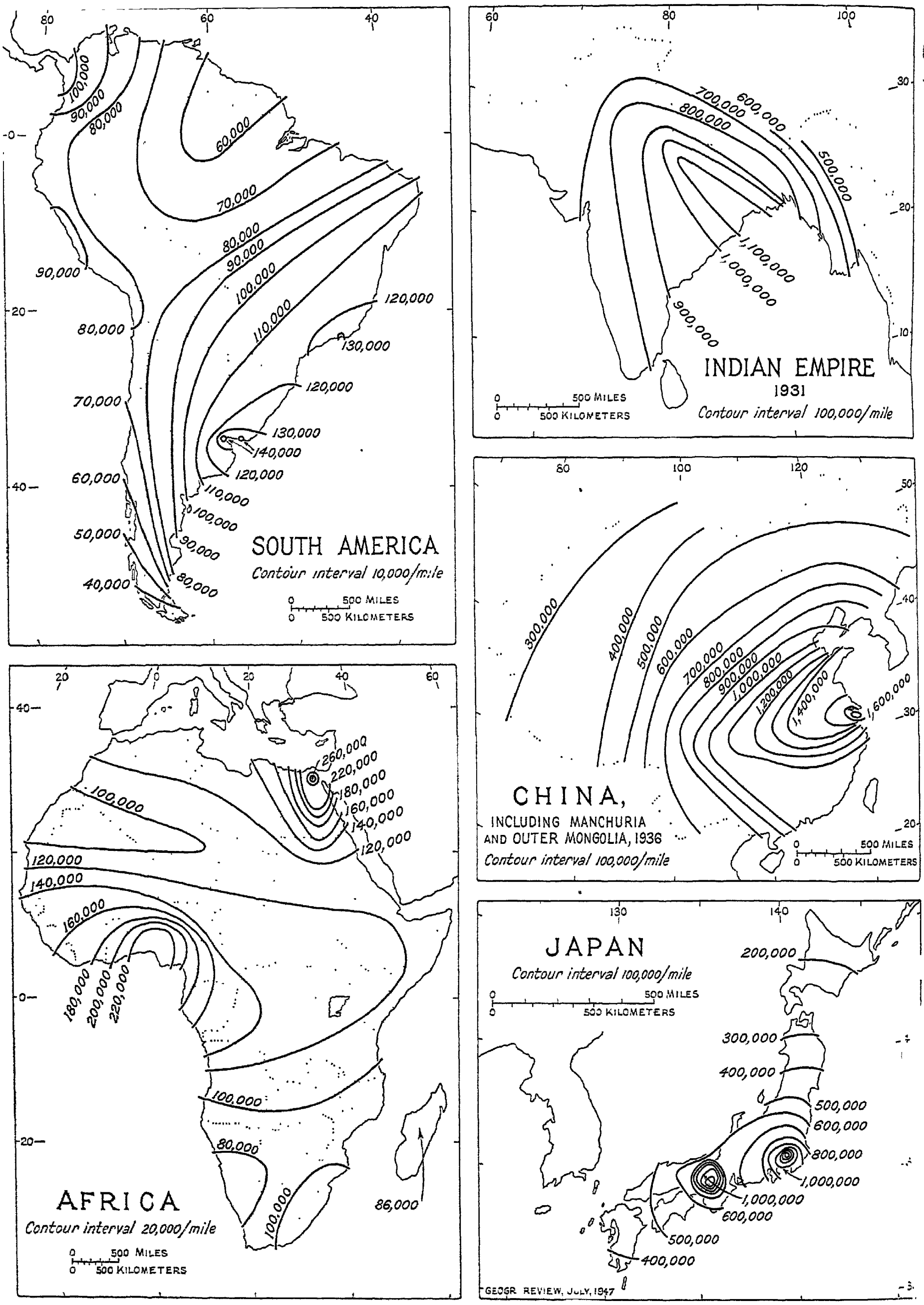


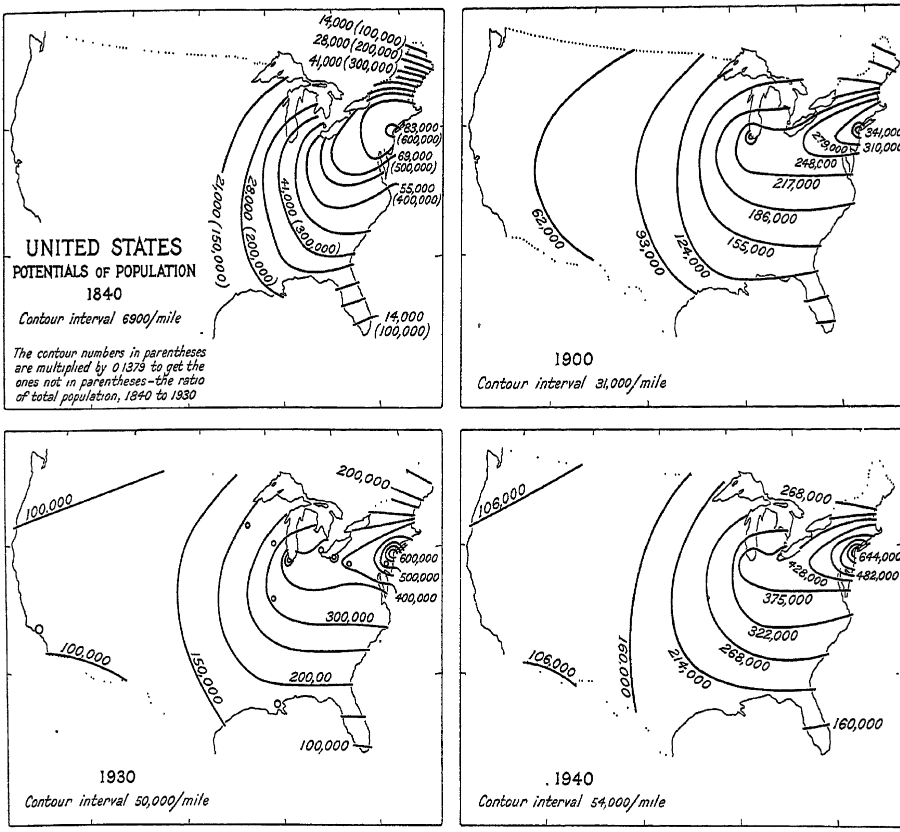
FIG. 4—Potentials of population for Europe in the 1930's. This map is the finest-grained yet computed, with 93 control points, as compared with only 24 for the United States. Consequently relatively minor inflections in the contours are presented with reasonable accuracy. The kilometer is the unit of distance: potentials are in persons per kilometer and must be multiplied by 1.609 to give persons per mile. (Dudley Kirk and Population Research Office.)

The potential of a district on itself can be approximated by one of a number of expedients. Under no circumstances in actual practice is it excessively large. For example, the potential at the center of a disk having uniform density of population can be computed (by integral calculus) as the population divided by half the radius.

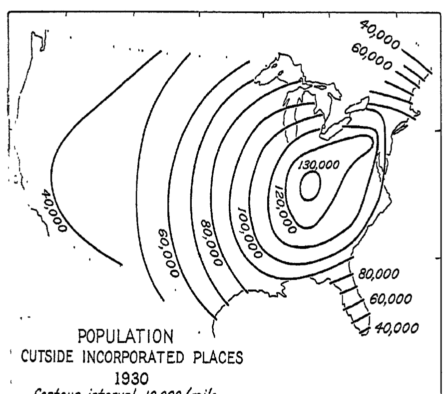
Even the potential of a person "on himself" is finite. If we take, for purposes of illustration, a man's average distance from himself as one foot or 1/5000 mile, the potential comes out 5000 persons per mile. This is far less than any potential represented in Figure 3 for the United States. Since potential of population is population divided by distance, it is always expressed in units of people per mile or per kilometer, or in millions of persons



FIGS. 5–9—Population potentials for South America, Africa, India, China, and Japan. Potentials are in persons per mile. The map f India is only a rough approximation. The major peaks of potential in every continent are at salt-water metropolises. The demograph influence of great river valleys is clearly evident except in the case of the Amazon.



FIGS. 10–13—A century of increases in population potentials in the United States. Contours on successive maps refer to potentials (in persons per mile) which have been selected in proportion to the nation's total population—which increased by a factor of about 7 from 1840 to 1940. If this increase had been uniform in every state and county, successive maps would be identical. Actually contours which in 1840 extended west of Chicago have moved farther west, while those east of Chicago have tended to cluster closer to New York.



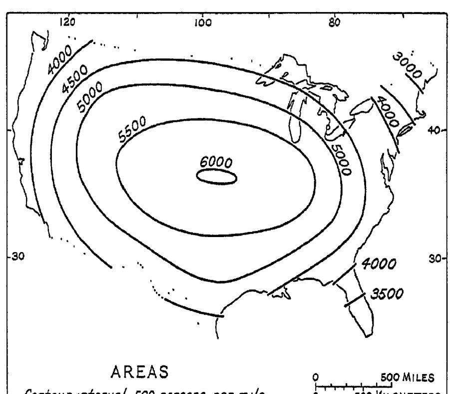


FIG. 14—Potentials for population outside of incorporated places in the United States, 1930. The peak potential is not far from Cincinnati and Louisville.

FIG. 15—Potentials for uniform population density in the United States. If one person lived in each square mile of land area, the total population would be 2,977,128, and the peak potential, about 6000 persons per mile, would be in Kansas. Compare with Figure 3; so much for the illusion that Kansas is the demographical center of the country.

per mile, etc. Density of population is expressed in persons per unit area—square mile or square kilometer.

If a potential map is computed by means of a large number of small districts, such a "fine-grained" map will show that every city constitutes a local peak of potential, large or small. In a large city there is heavy concentration of population toward the center, but the peak potentials do not exceed 2 or 3 millions per mile.

Discussion of the Maps

The maps of population potential, Figures 3 to 9, have two striking features in common. The major peak in every concentration (except for Nigeria) is a seaport metropolis, from which runs a dominant axis or "ridge," descending gradually in the hinterland.

In some cases, namely Calcutta–Ganges River, Shanghai–Yangtze River, Cairo–Nile River, Nigeria–Niger River, the major peaks and their ridges might be explained in part or wholly as a matter of easy internal communication and fertility of soil. But for New York and London the explanation is not so simple. The fact that these cities are the dominant peaks of their great human massifs must indicate the nonisolation of the two continents. An isolated human grouping would be expected to have its major peak near its center, provided the natural resources there permitted it—and certainly not away off at one side, next to the empty sea.

Figures 10 to 13 show developments in the United States since 1840. Even in 1840 New York was already established as the dominant peak, though the axis west of Pittsburgh then ran down the Ohio River. That was the effect of good agriculture and easy river communications.

School children hear much of the westward growth of this country. The growth is evident in the contours west of Chicago: in this little series of maps they have moved westward. But there has been another development, which has involved many more people, although less area—the growing prominence of the New York peak, which had barely been established in 1840. This represents, in effect, not a westward but an eastward migration!

A potential map for 1790 (not included here) shows different contours—long semiellipses extending north and south, with New York City not yet the major peak but enjoying the central position on a relatively high principal "plateau" that extended perhaps from Richmond, Va., to Salem, Mass.[25] It may have been even then a blunder in demography to establish

[25] Computations by C. R. Rourke and J. W. Thompson, Princeton undergraduates.

Washington, D. C., instead of New York, as the federal capital. The Ohio River axis of 1840 was, of course, not yet evident; instead there was the line of Cumberland Gap toward Kentucky.

In physics the rate of change of potential with distance in any direction measures the "field intensity" in that direction. The field intensity is the number of people divided by the square of their distance away; it is a directed, or "vector," quantity, while potential is a "scalar" quantity without direction. "Lines of force" define the field and always run at right angles to the contours of equipotential. The sharpening of the New York peak, which presumably is still going on, is one indication that in this respect also the physical analogue carries into demography. Populations tend to shift slowly along the lines of force toward the peaks of potential. Japan's double peak has endured in defiance of this tendency, because the mountains that intervene keep the Tokyo-Yokohama and Kyoto-Osaka concentrations separated, notwithstanding their mutual attraction.

Major routes of communication, such as river valleys, show up on density maps as thickly settled ribbons and therefore of necessity are evident on the potential maps as lines of force, at right angles to the contours of equipotential.[26]

Figures 14 and 15 are additional potential maps. Figure 14 is for one class only of the population, people living outside incorporated places in 1930. The old Ohio River axis is still dominant in this agricultural picture. The peak is far from New York. (A map for the rural farm population ought to be made.)

Figure 15 shows what would result if the whole country were populated with uniform density, one person per square mile. The maximum potential of 6000 persons per mile in Kansas thus applies for a total population of only about 3,000,000. If this were increased to the 132,000,000 of 1940, the level would rise to 260,000 persons per mile, as compared with the actual 650,000 in rural territory near New York City in Figure 3.

Apologies are due to our Canadian friends for the failure of all these

[26] Reilly stated a "law of retail gravitation" for trade areas, which described the equilibrium point or "breaking point" between two competing cities; he used population divided by the square of the distance. See W. J. Reilly: Method for the Study of Retail Relationships, *Univ. of Texas Bull. No. 2944*, 1929. Some such rule as his would follow from the concept of potential of population, if a given trade area extended only as far as the farthest-out contours of potential which closed around a city. For a recent study of this phase, see P. D. Converse: A Study of Retail Trade Areas in East Central Illinois, *Univ. of Illinois Bull.*, Vol. 41, No. 7 (Business Studies No. 2), 1943; also his "Retail Trade Areas in Illinois," *ibid.*, Vol. 43, No. 68 (Businesss Studies No. 4), 1946.

An early examination of the distance factor in sociology was made by J. H. S. Bossard: Marriage and the Child, Philadelphia, 1940, Chap. 4.

United States maps to include the potential exerted by the population of Canada. That is not large enough to be of primary importance, even along the frontier, but no doubt it ought to have been included.

The typical major-peak-and-ridge distribution deserves further thought and comment. It is clear that the tendency of the summed coefficients N_1N_2/d for a human grouping to tend toward a maximum must be resisted by a counterbalancing tendency, or "demographic force." Otherwise there would be one city at the peak and no ridge or rural lowlands. The student in elementary celestial mechanics is told that a planet's gravitation toward the sun is balanced by the centrifugal force of the planet's orbital motion. The corresponding outward demographic tendency can also be given mathematical expression, but this is reserved for a later paper.

Thus the ridges down from the major peaks seem to be a result of the tendency for people to draw together, while at the same time some of them must keep spread out in order to maintain thorough contact with the soil and the herds, the minerals and the sea.

"Induced" Rural Population

By no means all dwellers in rural areas are occupied directly with rural matters. A large number are there to perform services for the remainder; and many others, who work in cities, live in the country for one reason or another. Acreage that is near many people—and thus at a high potential of population—is likely to be utilized for the residences of commuters, and also of local workers, because such an area offers special opportunities for livelihood. One expects, then, a relationship between potential and the density of rural population. The relation previously announced[27] has been abundantly confirmed:

$$D_R = k\,V_T^2, \tag{13}$$

where V_T is the potential at any point produced by the total population, D_R is the rural density at and near the given point, and k is a constant for the isolated human grouping that is being considered (the United States or Europe).

This equation has been verified for all the censuses of the United States that were studied; namely 1840, 1900, 1930, and 1940. Agreement state by state is relatively more regular in later years.

Equation 13 evidently is equivalent to

$$P_r = k\,V_T^2\,A, \tag{14}$$

[27] Stewart, An Inverse Distance Variation; *idem*, Coasts, Waves, and Weather, p. 164.

where P_r is the rural population of a given small area A having potential V_T^2. Summing (14) over the entire United States, or any district thereof, we have

$$P_r = k \Sigma V_T^2 A, \tag{15}$$

P_r being the total rural population of the district. This equation permits the easy determination of k from the observed data. Values of V_T are taken

TABLE V—RELATION OF THE DISTRIBUTION OF THE U. S. RURAL POPULATION (1940) TO THE POTENTIAL OF THE TOTAL POPULATION (EQUATION 15)

State	$V_T^2 A$	P_R		State	$V_T^2 A$	P_R	
		Obs.	Comp.			Obs.	Comp.
N. J.	26×10^{14}	77×10^4	92×10^4	Vt.	8×10^{14}	24×10^4	28×10^4
Conn.	13	55	46	N.H.	8	21	28
R. I.	2	6	7	Wis.	40	146	141
Penna.	90	331	318	Mo.	51	182	181
Del.	4	13	14	Iowa	35	145	123
Mass.	17	46	60	Me.	12	50	42
Md.	18	74	63	Kans.	36	105	127
N. Y.	77	231	272	Minn.	32	140	113
Ohio	62	229	219	Okla.	30	146	106
W.Va.	34	137	120	Nebr.	28	80	99
Ind.	51	154	180	Tex.	84	350	295
Ill.	73	209	257	S.D.	20	48	70
Va.	52	173	183	N.D.	14	51	49
Ky.	48	200	169		——	——	——
Mich.	57	180	201	Sums	1022	3603	3603

NOTE.—The over-all ratio 3603/1022, or 3.525, is multiplied into each V_T^2A to get the computed P_R, which compares well with the observed values. Values of V_T were taken by inspection from Figure 3—a rough average for each state. In the table the states are arranged in decreasing order of the potentials, from 520,000 for N. J. to 140,000 for N.D. In the products V_T^2A the unit of area is the square mile.

from a potential map for each area A, averaged, by inspection, over the area.

In Table V data for 1940 are given for 28 states east of Colorado, not including nine states of the deep South. The indicated value of k is

$$(351 \pm 45) \times 10^{-12} \text{ people}^{-1}.$$

The "probable error" of only 13 per cent shows the regularity of the agreement.

But when the rural equilibrium so indicated is extended to the deep South, we have the results of Table VI. Each of the nine states had an excess over the computed rural population. The total excess amounted to 5,600,000. For comparison, the total rural Negro population of these states in 1940 was about 5,000,000. The agreement is doubtless significant.

The equilibrium of Table V holds also for the 11 Rocky Mountain and Pacific Coast States if all are taken together. A deficit of about 2,000,000 rural

dwellers below the formula in the eight states of mountain and desert is balanced by an equal surplus in the three Pacific states.

It is worth noting that (13) is the only form of the relation—of rural density to potential of total population—that is independent of absolute space. If the United States were to be doubled in length and breadth while the same people kept on living in the same counties, the existing rural

TABLE VI—"OVERPOPULATION" IN RURAL DISTRICTS OF THE DEEP SOUTH (1940)

State	$V_T^2 A$	P_R Obs.	P_R Comp.
N. C.	49 x 10^{14}	260 x 10^4	173 x 10^4
Tenn.	42	189	148
S. C.	22	143	78
Ga.	40	205	141
Ala.	32	198	113
Ark.	33	152	116
Miss.	28	175	99
La.	22	138	78
Fla.	15	85	53
Sums	283	1545	999

NOTE.—The excess of actual observed rural population over that computed is 5,460,000. Values of P_R computed are obtained by multiplying the numbers in the second column by 3.525, according to the equilibrium established in the states of Table V.

equilibrium would not be disturbed, because all potentials would be reduced by a factor of two while all areas would be increased by a factor of four.

The equations hold also for Europe, for censuses in the 1930's corresponding to the potentials of Figure 4. The most conspicuous deviation there is a latitude effect. There are fewer-than-formula rural dwellers in the high northern latitudes of Scandinavia and Russia if the value of k is chosen so as to give the best average fit for all of Europe (that is to say about 150 x 10^{-12} people^{-1}).

It is thus proved that potential of population, as regards the effect on rural population density, can jump international boundaries as though these were nonexistent. Sociologists point to the relatively small movement of people across certain European frontiers, but physicists know that, although rapid mobility within a system shortens the tim . equilibrium, the characteristics of the equilibrium itself ent of this time, whether long or short. Equation 14 an ;, describe an equilibrium of the rural population, in relation to the total population. Presumably *some* mobility, rather than *large* mobility, is enough to establish this equilibrium everywhere.

At present writing, the four empirical rules, equations 1, 11, 13, and the equation for potential of population, must be considered mutually independent. The equation for potential (or energy) is doubtless the fundamental one, and it is possible that a way will be found to derive one or more of the other three from it.

The rank-size rule for cities presumably expresses an equilibrium that results from urban competition. The rural-density rule, equation 13, as has been said, expresses an equilibrium between the rural population and the total population. The existence of any relation of C to U, such as equation 11, points to a third equilibrium—one between the rural and the urban populations as a whole.

Further applications of the rank-size rule have been worked out and will be published later, including applications that hold for relatively small samples of people; namely those classified by the census as employed in some particular occupation in each of the larger cities of the United States. Still other empirical relations, not touched on at all in this paper, have been found.

There is no longer excuse for anyone to ignore the fact that human beings, on the average and at least in certain circumstances, obey mathematical rules resembling in a general way some of the primitive "laws" of physics. "Social physics" lies within the grasp of scholarship that is unprejudiced and truly modern. When we have found it, people will wonder at the blind opposition its first proponents encountered.

Meanwhile, let "social planners" beware! Water must be pumped to flow uphill, and natural tendencies in human relations cannot be combated and controlled by singing to them. The architect must accept and understand the law of gravity and the limitations of materials. The city or national planner likewise must adapt his studies to natural principles.

"THE NATURE OF GEOGRAPHY"

A COMMENTARY ON THE SECOND PRINTING

LESTER E. KLIMM

This is a question of words and names.
I know the strife it brings.
I will not pass upon any your claims.
I care for none of these things.

THUS, in Kipling's version, did Gallio, the Roman deputy, reprimand certain citizens of Corinth who complained that Paul was persuading men "to worship God contrary to the law." It may not be too presumptuous to compare the situation and Gallio's aggressive indifference with the impatience of some mature workers in the field of geography with what Sauer, in his presidential address before the Association of American Geographers (1940), called "the pernicious anemia of the 'but-is-this-geography' state." They maintain stoutly that geographers should work at geography and not spend valuable time arguing as to what it is!

One may sympathize with Gallio and Sauer and yet conclude that both Corinthians and geographers must answer these questions of "words and names." In 1939 the Association of American Geographers published Richard Hartshorne's "The Nature of Geography: A Critical Survey of Current Thought in the Light of the Past."[1] The editor, in a foreword, pointed to the contemporary interest and controversy in definition and methodology and stated: "To those debates and articles the monograph offered here is in a sense the capsheaf."

The Field Defined

Hartshorne starts with the assumption that the nature of geography is not to be determined by deductive theorizing or the etymology of its name but by study of the development of the field through its long history. Because German geographers have been most concerned with speculation on methodology and definition, he depended to a considerable extent on German contributions; but others were not neglected. Of the Germans, he was most influenced by Hettner; in fact, his conclusions apparently differ from Hettner's in no important respect.

Geography has become, he says, a study of the "areal differentiation of the world" (p. 462). This leads to an emphasis on regional studies, but the author denies that regions in themselves are "natural" or "organic." The combination of regional and systematic approaches makes geography "dualistic."

Examination of past and present developments impels the author to a denial of the adequacy of "science of the planet earth," "science of relationships," and "science of distributions" as definitions of the field. He concludes that it is vain to think of geography as a "science" in the sense that physics is a "science." He examines confusions inherent in the concepts of *Landschaft* and "landscape" and decides that these concepts have little to contribute to the definition of geography.

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[1] *Annals Assn. of Amer. Geogrs.*, Vol. 29, 1939, pp. 171–658. Five hundred bound copies of the monograph alone were also printed, paged 1–482 at the bottoms of the pages. Citations below are to bottom-of-page numbers.

The author also expresses considerable doubt whether time and space relationships can be combined satisfactorily into historical geography. He urges that developmental studies belong either to the systematic sciences or to history.

Use in Instruction

The original printing has been exhausted, and a second printing[2] has been issued in book form. By April 1, 1947, about 1240 copies of the numbers of the *Annals* containing the article and the separate books (both first and second printings) had been distributed. Although some of these went to libraries and exchanges and a few to subscribers abroad, this is a remarkable distribution for a methodological work in a discipline that contains fewer than 1000 practitioners in the United States.[3] The number of so-called "mature workers" is considerably smaller, since there were but 291 persons holding doctorates in geography in this country in 1943.[4] It would appear that Hartshorne's work has probably reached most active members of the profession and many other persons. That the demand for this study is continuing is shown by the fact that 113 of the 600 copies of the second printing had been sold between its appearance early in 1947 and April 1 of the same year.

In an attempt to determine the way in which "The Nature of Geography" has been used in the training of geographers since its issuance, a questionnaire was addressed to the 14 departments of geography in the United States and Canada that granted 150 of the 162 doctorates completed between 1935 and 1946.[5] Three new or enlarged departments that had not offered programs leading to the doctorate before World War II were also included. Replies were received from 16 (of the 17) institutions.

The replies disclosed that "a course which deals with the nature or philosophy of geography or with the history of geographic thought" was offered by 14 institutions; 10 made it a required course for graduate students in geography (two requiring it only of Ph.D. candidates); and three a required course for undergraduates (two for majors only).

"The Nature of Geography" was used by one institution as "the principal text in such a course" (in this case graduate); 15 used it as assigned reading in some course; three assigned the complete work; four required "candidates for the Master's degree in geography to be thoroughly familiar with this work" (two more hedged on the "thoroughly"); seven reported that they "require candidates for the Doctor's degree in geography to be thoroughly familiar with the work" (three more hedged on the "thoroughly," and two more replied that "most candidates used it").

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[2] Photolithoprint "Second Printing, 1946." This contains an additional "Preface to the Second Imprint," an "Abstract" (pp. vii–xv), 128 additional bibliographical items (pp. xvii–xxiv), and "Corrections and Supplementary Notes" (pp. xxv–lii). This printing is numbered only at the bottoms of the pages and does not give the page numbers of the volume of the *Annals* in which the monograph first appeared. Obtainable from Professor Ralph H. Brown, editor, University of Minnesota, Minneapolis 14, Minn., $2.00.

[3] In 1943 a National Research Council committee found that there were "about 800 persons with training in geography." See the abstract of W. L. G. Joerg's report, *Annals Assn. of Amer. Geogrs.*, Vol. 37, 1947, p. 39.

[4] From a manuscript copy of the N.R.C. committee's report in the writer's possession.

[5] See the abstract of the study by Leslie Hewes entitled "Summary of Survey of Dissertations in Geography," *Annals Assn. of Amer. Geogrs.*, Vol. 37, 1947, pp. 38–39. See also his list of "Dissertations in Geography Accepted by Universities in the United States and Canada for the Degree of Ph.D., June, 1935, to June, 1946, and Those Currently in Progress," *ibid.*, Vol. 36, 1946, pp. 215–247.

In answer to a request for comment on its "value . . . in the education of students in geography," five departments gave unqualified approval; four considered it valuable but expressed criticisms of verbosity and involved and obscure argumentation; two made no comment; one said it was used by the students but was too long and involved to be useful for assigned reading. Four replies were strongly critical, complaining, among other allegations, that it was wordy and difficult to read. Several reviewers have voiced a similar sentiment.[6]

There can be no doubt that these characteristics have detracted from the usefulness of the work, but it must be noted in all fairness that it was not intended by the author to be used by nongeographers or by young students; as he himself states in the "Preface to the Second Imprint," he "had primarily in mind his mature professional colleagues."

Changes in the Second Printing

The "Abstract" that has been added to the second printing is a useful guide through the maze of the nearly 500 pages of text. It is rather lengthy (9 pp.), but in general it is tightly and plainly written. The "Corrections and Supplementary Notes" (28 pp.) rectify a number of mistakes, comment on much of the new material, and reply to some of the critics. Certain of the replies might well have been omitted, or at least shortened. Some, however, offer "soft words" to the wrathful by stating attitudes and objectives that were, perhaps, not plain enough in the first printing.

For example, the author explicitly denies that he had any intention of "providing another dictum according to which specific works by geographers would be judged as admissible or inadmissible in the field of geography" (p. xxv). Whatever the intention, such judgments as to inadmissibility were expressed or strongly implied in the first printing and of course remain in the photolithoprint reproduction.[7] Moreover, his obiter dictum (pp. xxv–xxvi) on this subject in the "Corrections" seems to raise the question all over again. In replying to those who object that he has taken their writings too seriously as expression of their methodological beliefs or "object that views published a decade . . . earlier, but not corrected in similar publication, should have been considered as current views," he dismisses their objections as "equally irrelevant" (pp. xxvii–xxviii). The term "similar publication" is not clear; but whatever the implication, the writers in question can hardly be blamed for objecting. This remark is made, not to compound the author's felony of giving "an answer to an answer to an implication,"[8] but to point out that the additions to the first printing contain some of the original weaknesses.

Hartshorne has done a thorough job of searching out the methodological work done since the first printing and some earlier work not noted previously. The recent work in political geography gets especial attention, partly because this is one of the author's chief personal interests, partly because of the generally increased interest in this branch of geogra-

[6] For example, J. K. Wright, *Isis*, No. 88, Vol. 33, 1941, pp. 298–300, "This otherwise admirable and scholarly study would surely have been more effective had it been substantially condensed"; E. B. Wesley, *Social Education*, Vol. 5, 1941, pp. 313–314, "This treatment of an involved problem is long and in some instances very prolix."

[7] See, for example, the discussion of the work of Semple on pp. 122–124 and of Sauer on pp. 177–178, aggravated by the disclaimer that follows.

[8] See this specific objection to the original printing in the review by Wesley, *op. cit.*

phy. The classified bibliography of 400 items in the first printing has been enlarged by 128 items. This feature, alone, is reason enough to be grateful to the author.

There are, in this second printing, no marked changes in basic concepts, but there are some modifications. The author has yielded somewhat (pp. xlv and xlix) to Ackerman's objections to the characterization of geography as a dualistic science, i.e. regional and systematic. Ackerman argues that "the only distinction between systematic and regional geography is that between the part and the whole. Geography therefore is monistic, not dualistic."[9] In a personal communication (April 12, 1947) Hartshorne writes: "A paper written by one of our Brazilian fellows (Guimaraes) pushes me to a revision of statements on relation of Systematic and Regional Geography, possibly bringing me and Ackerman closer together."

Nothing is done in either the "Abstract" or the "Corrections" to clarify the confusion between "chorology" and "chorography." Richthofen's distinction between the two is paraphrased in the text as "a first step, chorography, which is non-explanatory description, providing material for systematic geography, and chorology, a final step, the explanatory study of regions . . . ; but this separation has not been followed" (p. 93). Not only has it not been followed; the two terms are used interchangeably many times. In the personal communication mentioned above, the author replies to a query on this point: "My own preference seems to have been 'chorologic' or 'chorology.' " However, in the final text chapter, entitled "Conclusion," "chorographic" or "chorographical" is used three times when the author is apparently stating his own conclusions, and "chorological" twice when he is paraphrasing Finch. This is more than "a question of words and names," especially to students who have been made acutely aware of the difference between *geology* and *geography*. Hartshorne is not alone in this loose usage, however, and in many cases the confusion arises because he is using the term employed by the authors he is paraphrasing.

A softening of attitude is apparent on the extent to which historical method is necessary in geographical research. After commenting favorably on the substantive works of Taylor, Huntington, and Sauer in the field of historical geography and noting the plea of Whittlesey[10] for a greater consideration of the time factor in geography, the author comes to the conclusion that the subject "requires much more consideration before we can expect even an approximately final answer" (p. xxxix).

"Velocity" and "Pace"

In discussing Whittlesey's paper, the author seems to have overlooked a subject that may become an important addition to geographical analysis. Whittlesey suggests that "velocity" and "pace" should be considered in geography. Certainly the speed with which area is traversed by man and goods (velocity) and the rate at which human activities move (pace) are among the significant differences between areas on this earth. They are reflections of, if not in part the causes of, many differences in "the geography of human productivity,"

[9] E. A. Ackerman: Geographic Training, Wartime Research, and Immediate Professional Objectives, *Annals Assn. of Amer. Geogrs.*, Vol. 35, 1945, pp. 121–143; reference on p. 134. It may seem particularly appropriate that a plea for geographical "Unitarianism" should come out of New England, especially Harvard. However, the writer of this review does not wish to be held accountable for any deterministic implications that may be read into the preceding sentence!

[10] Derwent Whittlesey: The Horizon of Geography, *Annals Assn. of Amer. Geogrs.*, Vol. 35, 1945, pp. 1–36.

to which Huntington urges that more attention be given.[11] There has been some consideration of velocity in the past, much of it in terms of city traffic and commuting times, but not much of it by geographers. The concept of pace, although not entirely new, is a stimulating approach. Economists have long used it in terms of "velocity" of the circulation of money and credit in price formulas and in studying style factors. The sociologists' "communication" has some of these aspects. As Whittlesey points out, differences in rate have been significant in all the biological sciences for a long time.

These may be examples of those combinations of time-place relationship the complexity of which promised to give Dryer (and Hartshorne) "a bad half-hour" (quoted in second printing, p. xxxix), but they must be faced.

An Introduction and a Stimulus

Altogether, the geographical profession owes Hartshorne a profound debt. The unique contribution made by "The Nature of Geography" was stressed by the reviewers of the first printing. It "has few counterparts in geographic literature—certainly none in English," said Wellington D. Jones.[12] The same thought was expressed by the reviewer (G. C.) in *Geography*, and we may well add his conclusion that, because of "the fact that the social and political history of our own time appears to foreshadow great changes in the constitution and social relations of scientific work, geographers will need to understand the *rôle* of their own subject within the system of sciences and its relation to social life through spatial planning. To do that they must clarify their concepts of the philosophical and methodological basis of geography, and in this respect Hartshorne's book provides a most timely reminder and comprehensive introduction."[13]

The value of this work does not depend on agreement with its conclusions. It has served to broaden the horizon of American geography by making available to all advanced students the principal methodological ideas of the Germans. This knowledge is no substitute for facility in German; in fact, it is hoped that it will stimulate further examination of methodological and substantive works in that language. By showing what inspiration may be derived from acquaintance with thought in other countries, it will perhaps encourage American students to acquire such ability in other European and Asiatic languages that they may serve as tributaries by which the thinking of serious workers everywhere may be added to the stream of geographical thought in English.

Hartshorne's monograph may not be the ideal work for the instructional use to which it has been put, but its wide distribution indicates that it has met a real need. It has certainly stimulated methodological writing by others. The second printing, with its abstract and bibliographical additions, has many advantages over the first. The next step should be a thorough reorganization and rewriting such as the author suggests in the preface to the second printing.

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[11] Ellsworth Huntington: The Geography of Human Productivity, *Annals Assn. of Amer. Geogrs.*, Vol. 33, 1943, pp. 1–31.

[12] *Annals Amer. Acad. of Polit. and Soc. Sci.*, Vol. 210, 1940, pp. 176–177.

[13] *Geography*, Vol. 26, 1941, p. 99.

AMERICAN GEOGRAPHICAL SOCIETY

The March Meeting

The regular monthly meeting of the American Geographical Society was held on March 18, 1947, at the auditorium of the Engineering Societies Building, 29 West 39th Street, Dr. Richard U. Light, President of the Society, in the chair. Dr. Alfred M. Bailey, director of the Colorado Museum of Natural History, addressed the Society on "High Country." His lecture dealt with our Western mountains above 9000 feet, the flora, bird life, and big game through the seasons; it was illustrated by a superb motion picture in color.

The April Meeting

The regular monthly meeting of the Society was held on April 15, 1947, at the auditorium of the Engineering Societies Building, 29 West 39th Street, Mr. Raye R. Platt of the Society's staff presiding. Mr. Earl Parker Hansön, introduced by Vilhjalmur Stefansson, spoke on "Mission to Liberia." Mr. Hanson was chief of the United States Economic Mission to Liberia, and his address was a report on that country's problems and its interest for the United States (see his article in the January number of the *Geographical Review*).

Elections to the Council

At the meeting of the Council held on April 15, 1947, the following were elected members of the Council: Mr. Woodfin L. Butte and Mr. Robert Hyde MacMurphey. At the meeting of the Council held on May 22, 1947, Professor Lester E. Klimm was elected a member of the Council.

Our July Contributors

PROFESSOR DEBENHAM, professor of geography at the University of Cambridge, narrates an episode in his African tour (undertaken at the invitation of the Foreign Office), on which his mapping interests were pursued under very different circumstances from those of the Scott Antarctic expedition of 1910–1913, on which he served as a geologist and surveyor. Professor Debenham founded the Scott Polar Research Institute and acted as its director and editor of the *Polar Record* until his recent resignation.

MR. FIELD is a research associate on the staff of the American Geographical Society and vice-chairman of the Research Committee on Glaciers of the American Geophysical Union. Besides his many visits to Alaska for glacial study, he has carried out photographic expeditions in the Caucasus. DR. DAVIS is associate professor of geography at the University of Michigan. During the war he served as commander, U.S.N.R., and as plans officer of the Special Air Task Force, U. S. Fleet, with headquarters on the Russell Islands. To the *Geographical Review* he contributed the article "The Cities and Towns of the High Plains of Michigan" (October, 1938).

DR. FISHER, a graduate of the Sorbonne, served in the Middle East during the war—in Cyrenaica and Tripolitania and in Syria, where he acted as liaison officer to the French Haut Commissariat. While stationed in Beirut he collaborated with the distinguished French scientist L. Dubertret. To the *Geographical Review* he contributed the article on "The Lebanon" (April, 1944). He has recently been appointed to a lectureship in geography at the University of Aberdeen. DR. NUTTONSON is research director of the American Insti-

tute of Crop Ecology (see the *Geogr. Rev.*, Vol. 37, 1947, p. 314). DR. KALLNER, formerly on the staff of the Hebrew University of Jerusalem, is now associated with the Palestine Meteorological Service.

PROFESSOR STEWART is associate professor of astronomical physics at Princeton University. His entry into the "virtually non-existent" field of the numerical description of social phenomena might be said to have been signalized by his refreshingly different texts "Marine and Air Navigation" (with Newton L. Pierce) and "Coasts, Waves, and Weather for Navigators." To the *Geographical Review* he contributed the article "The Use and Abuse of Map Projections" (October, 1943).

DR. KLIMM, professor of geography at the Wharton School of Finance and Commerce of the University of Pennsylvania, has recently been elected to the Council of the American Geographical Society. His present contribution to the *Geographical Review* reflects his concern with geographic theory. He is also interested in economic and social phases of geography and has done field work in western Ireland, on which he contributed two papers to the *Geographical Review* (July, 1927, and October, 1935).

GEOGRAPHICAL RECORD

EUROPE

SOME RECENT GREEK PUBLICATIONS. Through the cooperation of Dr. Floyd E. Masten, the American Geographical Society has recently acquired a small collection of works of geographical interest published in Athens since 1935 (mostly in Greek). This consists of a world atlas and various publications dealing with the whole or parts of Greece. The atlas, a substantial volume (11½ by 9¼ inches) entitled "Universal Geographical Atlas," was issued in Athens by the magazine *Proïa* in 1936. Besides a comprehensive text and statistical tables, it contains some 105 maps reproduced in color, of which 20 are devoted to Greece.

Among the books and pamphlets dealing with Greece as a whole are: (1) an elaborate study by Baba Alivizatos of governmental policies, legislation, and achievements in the field of agriculture, illustrated with colored maps and graphs (The State and Agricultural Policy, Ministry of Agriculture, Athens, no date [1938?]); (2) a geographical dictionary by Gregory Stephanos, giving concise facts, historical and contemporary, about localities throughout Greece (Comprehensive Geographical Lexicon of Greece, Michael Saliveros, publisher, no date [1937?]); and (3) certain statistical publications of the Ministry of National Economy, notably mineral statistics for 1939 and population tables based on censuses of 1928 and 1940. (4) Of broader general interest is a handsome volume issued by the Ministry of Reconstruction in 1946, in Greek, French, English, and Russian. The English title is "The Sacrifices of Greece in the Second World War." The introduction explains that the aim is "to give to the international public opinion a summary picture of the price paid by the Greek people in the defence of the great ideals of freedom and justice, which has so far remained practically unknown." This picture is vividly presented by means of maps in color, graphs, and photographs, covering the general geography of Greece, the progress of the war, economic warfare and its effects (such as the destruction of livestock and forests), the destruction of public works, damage to towns and villages, and, finally, the sufferings of the inhabitants.

The collection also includes three maps of Greece as a whole: (1) a road map in six sheets on the scale of 1:500,000 (Map of the Road Network of Greece, 4th edit., Ministry of Public Works, Topographical Survey, 1945), depicting in conventional style drainage in blue, contours in brown, railroads in black, and roads in red, with differentiation of projected roads and those under construction; (2) a tasteful soils map by N. Liatsika, 1:1,000,000 (General Soil Map of Greece, Ministry of Communications, Topographical Survey, 1942), on which the petrological characteristics of the soils (whether clayey, sandy, stony, and so on) are distinguished by eight basic patterns in black, with 19 overprinted symbols in color representing types of soils; (3) a hand-colored outline map, 1:1,000,000, prepared by the Ministry of Agriculture, showing plains in green, and by means of point symbols cotton gins, cotton-weaving establishments, and the areas of land under cotton cultivation in 1946.

Three works in the collection have to do exclusively with northern Greece. (1) The most important, a publication of the Geological Survey of Greece, is a 141-page volume in German by Dr. Kurt Osswald of Munich, entitled "Geologische Geschichte von Griechisch-Nordmakedonien" (*Denkschriften No. 3,* 1938). It is a comprehensive survey of the geology of Greek Macedonia, arranged according to geological age, with an extensive bibliography to 1931 (supplemented by a leaf for the period to 1939), and is accompanied by an elaborate

geological map, 1 : 300,000, in two sheets, on which more than 50 formations are differentiated in color and a variety of symbols are used to show faults, folds, hot springs, mines, and the like. (2) The history of the turbulent landward frontiers of Greek culture on the north is discussed in a brochure by Diogenes A. Xanalatos entitled "The Limits of Hellenism in the Balkans" (Association for the Propagation of Greek Literature, Athens, 1945). Some 23 maps, mostly in color, with explanatory text, depict the boundaries of Greek states at various dates from the time of Alexander the Great, and also those of Bulgaria at contemporaneous periods "according to the Bulgarians." (3) The abode of the gods is shown in detail on a forest map in four sheets, 1 : 100,000, covering the area from the Vale of Tempe northward and northwestward to the Haliakmon River and Lake Ostrovo, and including Mt. Olympus (Map of the Forests of Olympus, Pieria, and Vermion, Ministry of Agriculture, no date [1937?]). Colors disclose the predominant types of trees, whether oaks, pines, firs, chestnuts, and so on, and symbols in black indicate the state of the forest, whether sparse, partly used for pasture, or largely destroyed.

It may also be noted that the Society has been fortunate in obtaining through Dr. Masten the text volume, by E. G. Mariolopoulos, published in Athens in 1937 and entitled "La distribution des éléments météorologiques en Grèce," to accompany the "Atlas climatique de la Grèce," by E. G. Mariolopoulos and A. N. Livathinos, which had appeared in 1935 and was already in the Society's collections. Both of these are in French.

AFRICA

A PLAN FOR THE MECHANIZED PRODUCTION OF GROUNDNUTS IN EAST AND CENTRAL AFRICA. This is the title of a White Paper (*Cmd. 7030*) recently laid before the British Parliament by the Minister of Food. "Operation Groundnuts," as it has aptly been dubbed, is worked out with the care and urgency of a military operation. The objective is indicated thus: "The world is to-day suffering from a critical shortage of oils and fats, the annual shortfall in the case of Britain alone amounting to the equivalent of 1½ million tons of groundnuts."

The groundnut or peanut (*Arachis hypogaea*) is a plant of the tropics and subtropics; it thrives in light, sandy soils and has moderate water requirements—20 to 25 inches in the growing season. In Africa it has for many years been a main staple of the peasant farmers of northern Nigeria and the French Sudan (see, for instance, Helen T. Gilles: Nigerian Groundnuts Help Feed Starving Nations, *Farm and Forest*, Vol. 7, Ibadan, 1946, pp. 5–10). But it is "only by the most highly mechanised forms of agricultural development that the present critical position can be substantially improved." This means that large areas of topographically suitable land must be available. Parts of East Africa meet the conditions. Especially in Tanganyika Territory there are vast extents of vacant country (cf. Clement Gillman: A Population Map of Tanganyika Territory, *Geogr. Rev.*, Vol. 26, 1936, pp. 353–375). Inability of the natives to obtain domestic water and the invading tsetse fly are deterrents to occupation. The fly can be eliminated by bush clearing, and water can be provided by deep wells or storage tanks to catch the seasonal rainfall.

The creation of 107 project units is recommended: 80 in Tanganyika Territory, 17 in Northern Rhodesia, 10 in Kenya. Under mechanization the labor needs would be relatively small. It is estimated that bush clearing would initially call for 25,000 natives and thereafter for a force of about 300 per unit. The initial European personnel would be about 500; there-

after 750 would be needed for all functions, including research. Research should be carried on from the outset. "The scientific programme of the first two years may be summarised under the headings of meteorology, soil fertility studies, soil survey and mapping, crop disease survey and variety testing." Soil conservation is stated to be the "over-riding factor" —a reassurance to those who have been disturbed by the way in which bush clearing to get rid of the fly has been followed by disastrous erosion. Conservation of soil moisture is especially important in the drier areas. Soil fertility is to be conserved by the use of fertilizers and a grass rotation, only half of the area to be under groundnuts at any one time. The total area is 3,210,000 acres (30,000 acres to a unit).

Good communications are essential. In Tanganyika Territory a new railroad and port facilities will be necessary in the Southern Province projects (55 units); "the site of the new port is a perfect natural harbor with a thirteen-fathom channel and other advantages believed to be unique on the whole coast of East Africa" (*New York Times*, April 11, 1947). An all-weather road and a branch line will serve the Central Province (15 units). A branch line will add to existing facilities in the Western Province (10 units). In Kenya one area is near the coast, whence shipment can be made direct to Mombasa; two projects in the highland Trans-Nzoia district can be reached by extensions to the existing line. The projects in Northern Rhodesia are adjacent to the railroad except for the Kapalala project, south of Lake Bangweulu. This somewhat isolated locality was selected in view of the "potentiality of this great stretch of well-watered country for groundnuts, rice, fisheries, and timber, which is urgently required by the Copper Belt," and the building of a railroad may be considered.

The need of flexibility in the execution of the scheme is emphasized. Expansion to include large-scale cereal production and various ancillary activities, such as animal husbandry, is envisaged. The form of management proposed is a public corporation sponsored and financed by the British government at the start, later to be transferred to the local governments, and ultimately to the African communities. For this "bold, imaginative and inspiring scheme" (*East Africa and Rhodesia*, Feb. 13, 1947) looks beyond the urgency of the moment to the future economic and social welfare of a tropical dependency.

Some words of caution are uttered by the eminent authority on tropical agriculture Dr. H. Martin-Leake (*Crown Colonist*, April, 1947). He questions the reliance on a grass rotation and believes the humus factor has not been adequately considered; he expresses doubts about the workability of the social plans and the functioning of the technical services.

More recently it has been announced that a British government mission will investigate the possibilities of large-scale mechanized production of groundnuts in West Africa.

AGRICULTURE IN MADAGASCAR. The rounding out of half a century of French sovereignty in Madagascar (1896–1946) has been the signal for a stocktaking of the island's agricultural economy in the form of a collection of essays by experts in such fields as agriculture, irrigation, entomology, forestry, and animal husbandry (Cinquantenaire de Madagascar, *Rev. Internatle. de Botanique Appliquée et d'Agric. Tropicale*, Vol. 26, 1946, pp. 333–504 [supplementary number on Madagascar]). Recent figures put the total area of cultivated land at about 3,310,000 acres, of which a little more than 40 per cent (1,335,000 acres) is in rice and slightly more than that (1,437,540 acres) is planted to other subsistence crops. Commercial crops occupy 625,000 acres and are characterized by the great variety of commodities produced for export. These include coffee, cacao, vanilla, cloves, pepper, cinnamon, and other spices, copra, raffia, tobacco, sugar and rum, and manioc flour and tapioca. Coffee

holds first rank among the commercial crops (A. Chevalier: L'évolution de la culture du caféier à Madagascar, pp. 390–398): in 1944 it accounted for more than one-third of the total value of exports. Production in that year was 23,500 tons, of which well over half was grown in the Fianarantsoa district.

Rice, although its export value is less than 4 per cent of the total, is the basic subsistence crop; about 11 per cent of the ricelands are irrigated (F. Ciolina: Hydraulique agricole et riziculture à Madagascar, pp. 405–422). Maize, potatoes, manioc, vegetables, and tropical and subtropical fruits are also included in the *cultures vivrières*, and there is a well-developed livestock industry (L'élevage à Madagascar, son importance, son avenir, pp. 491–498), which boasts some 6 million cattle, 420 thousand pigs, and 300 thousand sheep and goats. Nearly 12,500 tons of meat and meat products and about 400 thousand hides were exported in 1945.

In most respects the agricultural economy is beginning to show recovery from the diminished production of the war years. It seems unlikely, however, that there will be any considerable expansion (above prewar levels, that is) for a long time to come. As M. Chevalier points out (L'avenir agricole de Madagascar: Conclusions, pp. 501–503): "Il faut d'abord élever le niveau de vie des populations autochtones, composées pour les quatre cinquièmes d'agriculteurs."

ASIA

MAPS FROM THE SURVEY OF PALESTINE. A large and interesting shipment of maps, covering a wide range in scale, subject, and type, has been received from the Survey of Palestine. With the exception of the south-central and southeastern areas, the country has been mapped on the scale of 1 : 20,000; more than 125 sheets have been published. These maps, known as the "topocadastral" series, are based on original field work and show towns and villages, boundaries of village lands, and their main subdivisions. Contours are at 10-meter intervals. Detail is in black; orchards and plantations are in green; main roads, contours, and sand dunes are in orange red. The series is supplemented by special town maps, scale 1 : 10,000. To date, these cover the Jerusalem area (6 sheets), Haifa (4 sheets), and Jaffa-Tel Aviv (2 sheets). Contours are at 10-meter intervals, and plantations are in green, roads in red.

A less detailed but very clear survey is the 1 : 100,000 series, in 16 sheets, covering Palestine from the Syrian border to the south end of the Dead Sea. Contours are at 25-meter intervals. A large amount of cultural and political detail is given, including the locations of numerous historical sites. As on the topocadastral maps, various types of land cultivation are shown.

The 1 : 250,000 map of Palestine, in three sheets, covers the entire country. Altitude is indicated by layer tints at 300-meter intervals, with form lines at 100-meter intervals, and land below sea level is in green. Metaled roads are clearly marked in red. There is also a 1 : 500,000 road map, with altitude tints.

The Anglo-American Committee of Inquiry was instrumental in the compilation and publication of a series of five maps, originally appearing as an appendix to their report. The smallest, on the scale of 1 : 1,000,000, is a tentative land-classification map, compiled in collaboration with the Department of Agriculture, Lands, Irrigation and Statistics of the Government of Palestine (1946). Eleven categories are given in color, with their dominant use. Land not irrigated but well situated for water supplies and land now partly irrigated are

shown. Mean annual rainfall, with altitude tints, is shown on another map, scale 1 : 500,000. This map was prepared by the Palestine Meteorological Service, Department of Civil Aviation, in March, 1946. Six isohyetal symbols are used, from less than four inches to more than 43 inches.

Population and settlement statistics are given on a series of three maps: progress of land settlement to the end of 1945, showing lands settled, those surveyed for settlement, and areas of preliminary investigations; land in Jewish possession at the end of 1944, compiled by J. Weitz and Z. Lifshitz on behalf of the Jewish Agency; population, 1944. These three maps are on the scale of 1 : 250,000 and cover Palestine north of Beersheba. The population map is by the disk method, in four colors, showing the distribution of Moslems, Jews, Christians, and Druses. On the map depicting land in Jewish possession, lands are given in two categories: those of the Jewish National Fund (in blue) and company and private lands (in green). Each of these divisions has three grades: in full, shares in undivided land, and concessions. The map is also divided into three zones, with boundaries in red, to designate land transfer regulations as of 1940.

Another map included in this shipment from the Survey of Palestine is a geological map of the country north of Beersheba, scale 1 : 250,000, published in 1939. The southern sheets are now in course of compilation and will be issued shortly.

There are also some historical maps: "Jerusalem, The Old City," 1 : 2500, 1945; "Roman Palestine," 1 : 250,000, 1939; "Palestine of the Crusades," 1 : 350,000, 1944 (compiled from information supplied by the Department of Antiquities and Père Abel of the École Biblique et Archéologique Française); and "Palestine of the Old Testament," 1 : 500,000, 1946 (compiled by the collaboration of Père Abel, Dr. Glueck of the American School of Oriental Research, Professor Klein of the Hebrew University, and the British School of Archaeology). Detailed historical and archeological information is given, and the last two maps have interesting borders compiled respectively from Crusader coats of arms and Saracen heraldic emblems and from ivories found in the ruins of Ahab's palace at Samaria.

AFFORESTATION IN PALESTINE AND TRANSJORDAN. In "Conquering the Deserts of the Middle East" (*Crown Colonist*, Vol. 17, 1947, p. 141) Eric Hardy hints at various possibilities of "tree" cultivation in the arid lands of Palestine and Transjordan. During a visit to the Wadi 'Araba he found "considerable areas of sand-dune desert dominated by the large, woody desert shrub *Haloxylon persicum*, or the 'Ghada' tree of ancient travel literature . . . It would provide not only fuel, which is so valuable in these coal-less countries, but equally valuable charcoal, while its foliage would give food for desert livestock. It could also be planted to check the drifting sand belts of the desert and to reduce sandstorms." *Haloxylon persicum* is a main component of the Central Asian "Saxaul forests," as Professor M. Zohary has described (Outline of the Vegetation in Wadi Araba, *Journ. of Ecology*, Vol. 32, 1944–1945, pp. 204–213); its occurrence in the Wadi 'Araba is of "great interest from the plant geographical and practical point of view."

The North African tree *Pistacia atlantica*, previously unknown in Asia, has been found on mountainsides and in the desert of northern Syria. Recently J. D. Chapman of the Palestine Department of Forests, with Arab guides from the Transjordan Forestry Department, made an excursion through the mountains of Moab. Here was located "the forest of juniper, cypress and *Pistacia atlantica* remnants on the Trans-Jordan mountains north of historic Petra. These must be the remains of the great forest which provided the charcoal for the furnaces

at King Solomon's famous copper mines in the Wadi Arabah desert." Reference to the "extensive forests" in the northern part of the Syrian Desert and "smaller stands" in Transjordan is made by Professor Zohary in his review of plant communities of Palestine in the February, 1947, number of the *Journal of Ecology*. According to Captain Hardy, another economically interesting plant growing in the Jericho and lower Jordan Valley desert is the Dead Sea fruit, the apple of Sodom (*Calotropis procera*). This tall, much-branching, woody shrub is related to the common American milkweed.

In "Afforestation of Semi-arid and Arid Areas in Palestine" (*Empire Forestry Rev.*, Vol. 25, 1946, pp. 213-221) G. F. Gindel reviews work already accomplished and gives advice on procedure—the selection of stock and of time of planting, proper preparation and maintenance. For slopes in the arid zone the only natural vegetation he considers "worthy of propagation" is Christ's-thorn and *Pistacia atlantica*. He notes that the latter, besides its rapid growth and value as timber, is useful as a stock for grafting the nut tree *Pistacia vera*. On deeper soils tamarisk species, *Acacia tortilis* (the shittah tree), the sycamore fig, and the castor-oil plant are suitable. Of exotics, special mention is made of three Australian species: a eucalyptus, a casuarina, and the wattle *Acacia cyanophylla*. Emphasis is laid on wide spacing in planting and on the significance of soil temperatures (an illustrative table is given). Attention is directed to the marked effect of exposure, as it is seen, for instance, in remnants of the natural vegetation and in the survival and rate of growth of newly established forests.

RECLAMATION OF SALINE SOILS IN THE LOWER JORDAN VALLEY. Reference has been made elsewhere in this number of the *Geographical Review* (pp. 451 and 460) to the experiments in reclamation of the saline soils of the Lower Jordan Valley. A detailed report on the work has now come to hand in *Bulletin 39* of the Agricultural Research Station, Rehovot, by S. Ravikovitch. A map shows that of some 40,000 acres of favorable topography in the Lower Jordan Valley only 10 per cent is free from an excess of soluble salts and that the salinity may be 15 per cent or more. One of the worst areas, at the north end of the Dead Sea, with salinity as high as 16.5 per cent, was selected for the experimental work. The area was flooded for five to six months with an average application of 4000 cubic meters of water per dunum (1 dunum = 0.23 acre). The salt residue was reduced greatly, mainly to gypsum, not considered injurious to crops (tables show reductions at various depths). Soil structure was greatly improved, and the capacity for development of microorganisms. The plots were planted to irrigated crops grown in rotation—for instance, potatoes and cucumbers, clover and African millet, tomatoes and maize, and lucerne. After four years the salt content had not increased to any extent, and crop yields were good.

PROBLEMS OF LAND USE IN CYPRUS. "The Proceedings of a Conference on Land Use in a Mediterranean Environment" (Nicosia, 1947) is a discussion of various aspects of agriculture in Cyprus and related topics. Participants were officials of the Agriculture, Forest, Irrigation, Land Registration and Survey, and Co-operation Departments of the government, representatives of the Greek and Turkish farmers unions of the island and other nonofficials, and delegates from Palestine. The opening paper, on land use in relation to climate and topography in Cyprus, gives the general setting. Cyprus is an island of mountains and plains, with a "fairly representative" Mediterranean climate, though temperatures are rather more extreme than the average; rainfall is generally low, 14 inches at Nicosia, in the central plain, 38 inches at Trikoukkia, in the mountains. Forestry is an im-

portant topic, for even now, after long centuries of abuse and wastage, the forests are the best in the eastern Mediterranean; however, wanton firing, cutting, and grazing must be constantly combated. Conservation of water resources and of soil fertility are other problems. The report on malaria, once the curse of the island, is gratifying; it is now well under control, thanks to techniques adapted from those of the *gambiae* eradication campaigns in Brazil and Egypt. "As far as is known, Cyprus is the first country to attempt to eradicate malaria by a total war on the anopheles mosquitoes as a routine measure."

THE SITE OF BEIRUT. Of the many and varied aspects of urban geography, none is more fascinating than the physical relationship between city and site. This influence of topography on urban development and growth is the subject of an excellent study of Beirut by Etienne de Vaumas, "Le relief de Beyrouth et son influence sur le développement de la ville" (*Publs. Techniques et Scientifiques de l'École Française d'Ingénieurs de Beyrouth No. 11,* 1946).

Beirut stands on a rocky promontory some six kilometers long and two kilometers wide bounded on the west and north by the Mediterranean, on the east by the depression in which the Beirut River flows, and on the south by a low area of dunes and sand. The main topographic feature is a series of three marine terraces that rise in steps inland from the sea and are set off from each other by cliffs. The lower terrace extends the length of the promontory from east to west, at an elevation of some 10 to 20 meters. The middle and upper terraces exist as extensive patches in the eastern and western sections of the city, separated in the center by a bowl-like depression through which a number of thalwegs drain northward to the sea. The middle terrace lies at a level of 35 to 60 meters in the west and 50 to 70 meters in the east; the upper terrace has an elevation of 70 to 90 meters in the west and 80 to 100 meters in the east, reaching its highest point of 101.8 meters at the city's water tower. (The extent and elevations of the terraces are shown in some detail on a map accompanying the publication.) The distinct slope from east to west of the two higher terraces (about 20 meters in 4 kilometers or an angle of 0° 17′) indicates a period of uplift occurring after the formation of the middle terrace but ceasing before the formation of the lower terrace, which has maintained its horizontality. Also of interest in the geomorphological history of the site is the evidence of periods of insularity in Quaternary time.

With respect to urbanism, then, the topography of the site may be summarized thus: Beirut occupies a series of steps facing northward toward the sea and demarcated by cliffs whose height and continuity constitute an obstacle to circulation. Perhaps the most significant single physical feature so far as settlement is concerned is the amphitheater-shaped depression mentioned above, which provides a channel for communication between the heights and the sea. Another important factor is the harbor provided by the Bay of St. André, sheltered from the southwest winds that on the Lebanese coast are the most violent and bring the severest storms.

Settlement on the promontory goes back to prehistoric time, as there is abundant evidence to prove. The city of "Beruta" is mentioned on tablets dating from the fourteenth century before Christ. From that time to the present, several historical periods in the life of the city are distinguishable—Roman, Moslem, Crusader, Druse, and European. Until the nineteenth century Beirut expanded remarkably little, seemingly having reached its optimum under the Romans. The modern era, marked by a rapid growth in areal extent

and in commercial importance, may be said to date from the early 1860's when a carriage route between Beirut and Damascus was opened for the transport of passengers and freight. Beirut thus acquired the hinterland it had thitherto lacked. A few years later the opening of the Suez Canal (1869), and later still the establishment of rail connections both along the coast and into the interior, provided further impetus to development. A concession for the construction of harbor works was granted in 1887, and succeeding decades have witnessed continued additions and improvements.

Although the future of the city will be conditioned in large part by the reorganization of the Near East as a whole, it is safe to predict that Beirut will continue to exercise its age-old function as the crossroads at which the land routes north and south along the eastern Mediterranean littoral meet the sea routes from the Western world focused on Syria, Iraq, and Iran.

AGRICULTURE IN AZERBAIJAN. To those who are prone to think of the entire Iranian plateau as a stark and arid land, a recently published description of agricultural activity in the mountainous province of Azerbaijan may come as a distinct surprise (Julien Gautier: Notes agricoles sur l'Azerbaidjan, *Rev. Internatle. de Botanique Appliquée et d'Agric. Tropicale,* Vol. 26, 1946, pp. 193–202). Soils throughout the province are of good to excellent quality, largely volcanic or alluvial in origin. Rainfall is adequate, in places even abundant, but summer drought is usual, and irrigation is generally practiced.

Textile raw materials play a large part in the agricultural economy. Hemp, flax, and other fiber crops are widely grown; silk is produced in many areas; cotton is successful in parts of the Araxes and Qizil Uzun Basins where the autumn rains come late enough for the plant to mature; and sheep with long white wool of fine quality are raised in the high valleys, particularly in the mountains of the Turkish frontier region. The upland areas also produce cereals, forage crops, sugar beets, and livestock; the more temperate hill regions are noted for fine orchards. Apricots, apples, peaches, prunes, pears, grapes (both for wine and for raisins), almonds, and walnuts are grown in considerable quantity, most notably on the slopes of Sahand. A modern factory for drying fruits is located at Maragheh, and a winery at Gogan. The coastal strip along the Caspian supplies rice and, from the foothills behind the plain, tea. Tobacco is cultivated throughout the province.

Obviously, Azerbaijan possesses abundant and varied agricultural riches, and if the numerous dams and other irrigation works projected before the war are ever constructed, production can be greatly increased.

THE SOILS OF CEYLON. In 1935 a systematic investigation of the soils of Ceylon on the basis of modern soil science was begun by Dr. A. W. R. Joachim and his associates in the Department of Agriculture of that country. A preliminary survey based on these studies, the results of which have been published in a series of papers in the *Tropical Agriculturist,* was given as a presidential address by Dr. Joachim before Section B, Agriculture and Forestry, Ceylon Association of Science (A Review of Progress in the Study of the Soils of Ceylon, *Proc. First Annual Sessions, Ceylon Assn. of Sci.,* Part 3, Colombo, 1945, pp. 21–30; summary in *Bull. Ceylon Geogr. Soc.,* Vol. 2, 1947, pp. 12–18). The survey presents a generic classification of the soil types and a provisional soil map.

The soils of Ceylon are classified into 16 major types. These are grouped into five categories according to the dominant factors governing their character. (1) Most of the island is underlain by igneous and gneissic rock, on which laterite, known locally as *cabook,* and

lateritic soils have formed. The amount and seasonality of the rainfall control the distribution of these types. The "ultra wet" zone of the southwestern part of the island has reddish to yellowish laterite soils and lateritic loams; the "wet" hill region of south-central Ceylon has red lateritic loams; the "dry" zone, which has an annual rainfall of 40–75 inches and a pronounced dry season and which extends in a wide arc to the south, east, and, especially, north of the hill region, has red, reddish-brown, and dark-gray lateritic and nonlateritic loams. (2) The Jaffna peninsula and a narrow strip extending south from it along the northwest coast of the island have intrazonal soils: brick-red loams (terra rossa soils) and gray calcareous loams (rendzinas). (3) Extending almost the length of the east coast and along a stretch north from Colombo on the west coast are littoral deposits of Pleistocene and sub-Recent gravels and sands, on which lie red and brown sandy loams (coconut soils) and bleached white sands (cinnamon soils). (4) Surface soils of variable depth, rich in humic material, overlie laterites and lateritic loams and clays in some patches in southwestern Ceylon. The grasslands and fernlands, which give rise to these soil types, are ecological successions to the forest climax. Dr. Joachim believes that this transformation has "been effected by the periodical burning of the secondary vegetation for grazing." (5) Small areas of azonal soils occur on the ribbons of recent stream alluvium, and azonal *gley*-type soils are present under water-soaked paddy fields.

The soils differ considerably in fertility. Dr. Joachim stresses the fact that in Ceylon, even if the valuable topsoil were to be conserved, the "soil fertility would still decline rapidly under our conditions of heavy rainfall and high temperatures unless measures to ensure the replenishment of the soil nutrients are adopted."—SHANNON McCUNE

FLOOD PROTECTION FOR COLOMBO. The complicated problem of flood protection for the city of Colombo has yet to be solved in a practical manner (H. A. S. Smith: Some Surveys of Rivers in Ceylon, *Empire Survey Rev.*, Vol. 8, 1946, pp. 255–264). Colombo is situated at the mouth of the Kelani Ganga, about 25 miles north of another stream of considerable size, the Kalu Ganga. Most of the city has an average elevation of only 20 feet above sea level. The immediate hinterland consists of a series of shallow lakes, marshes, and paddy fields; and stretching to the south and southeast, almost to the Kalu Ganga, is another extensive area of marshy lowland, the Bolgoda Basin. In time of flood the Kalu Ganga pours water into this basin, mainly through a canal built by the Dutch during their occupation of the island.

The drainage basin of the Kelani Ganga is about 900 square miles in extent, that of the Kalu Ganga about 1100 square miles. Precipitation over the entire combined catchment area is very heavy—more than four-fifths of the region receives 125 inches and more of rain annually. The greater part of the drainage basins of the two rivers is steep and hilly, and the primary forest cover has been largely cleared to make way for tea and rubber plantations and paddy fields. As a result, soil erosion, rapid runoff, and a great amount of silt discharge complicate the problem of water control.

About 1938 the entire question of flood protection was reviewed, and it was decided that a fundamental requirement for efficient planning was a detailed survey of both streams. This was accordingly undertaken between 1939 and 1945. From the surveys scale models of the rivers have been constructed, simulating actual conditions as closely as possible. Investigations and experiments are being carried on with the aid of the models, and it is to be hoped that an effective system of protective works will result.

HUMAN GEOGRAPHY

WORLD PRODUCTION OF FATS AND OILS. The world-wide shortage of fats and oils has made plain to many a consumer the number and variety of commodities that utilize these substances, and the question of supply has become of more than academic interest. In 1945, according to recent statistics (Fred J. Rossiter and others: Fats and Oils: World Production and Trade, *U. S. Dept. of Agric., Office of Foreign Agricultural Relations, Foreign Agric. Rept. No. 11,* 1946), world production of fats and oils amounted to some 17,300,000 short tons—about 20 per cent less than the 1935–1939 annual average of 21,600,000 short tons. There was little improvement in the situation in 1946.

Every category of fats and oils—edible vegetable oils, palm oils, industrial oils, animal fats, and marine oils—was considerably below the prewar level. The greatest decline, as might be expected, was in the palm-oil group (including coconut oil, palm oil, and palm kernels), mainly owing to the widespread destruction of trees in the Philippines and the Netherlands Indies, both major producers. Marine oils (whale and fish) were also substantially down; even with an increase of production in 1946, the output remained at almost 75 per cent below the prewar level for whale oil and 50 per cent below for fish oil. Among the edible vegetable oils, the greatest decline was in cottonseed oil and olive oil. Two other oils in this group, however, showed almost phenomenal increases: production of sunflower oil in Argentina rose from 13,100 short tons in 1940–1941 to 73,400 short tons in 1944–1945, and production of soybean oil in the United States was also greatly increased. No figures are given for the soybean-oil production in this country, but some idea of the proportions of the increase may be gained from the data on the production of soybeans; this jumped from a 1935–1939 average of 56,200,000 bushels to a 1945 output of 191,700,000 bushels.

The authors estimate that it will be another three years or more before production comparable with prewar levels will be reached. Furthermore, a number of political and economic factors will doubtless combine to alter the former pattern of international trade in these commodities.

LAND CLASSIFICATION. Three recent articles on land classification offer evidence of the persistent interest in schemes to classify the land of our earth and find out how much of the different kinds there is. Most commonly this interest springs from the desire of those trained in the scientific disciplines for an orderly arrangement of facts, that their relationships may be better understood. Much land classification, however, is also undertaken to meet an immediate practical problem, as in determining where in the United States to encourage wartime expansion of peanut production. This latter kind of land classification is often not thought of as land classification at all and hence does not get described in the literature of the subject.

The three articles under discussion are concerned primarily with land classification as a scientific device, rather than as a tool to serve some limited immediate purpose. In reviewing different systems, however, J. P. van Aartsen, writing in the *International Review of Agriculture* (Land Classification in Relation to Its Agricultural Value: A Review of Systems Applied, Vol. 35, 1944, pp. 79S–98S and 139S–166S), and G. V. Jacks, in a report published by the Imperial Bureau of Soil Science (Land Classification for Land-Use Planning, *Technical Communication No. 43,* 1946), each include examples of both kinds of land classification.

The contributions of Mr. Jacks and Mr. van Aartsen are brief analyses of various systems for rating and classifying land in terms of its agricultural value or its suitability for different

kinds of agricultural use. Both limit themselves to procedures that have been described in the literature as "land classification." Hence neither includes such land-classification procedures as that used in the construction of rural zoning ordinances, notably in Wisconsin, which would have afforded a glimpse of a very different aspect of land classification, namely citizen participation in the process and the determination of land classes by democratic procedure, in contrast with classification solely by "experts." Mr. Jacks touches on the matter of citizen participation, but he does not consider it a feature of any kind of land classification. Perhaps he limits land classification to scientific classification by experts. If so, he cannot be blamed, because so many different kinds of things can be included under this head that any dissertation on it is likely to deal with a miscellany unless the term is defined more narrowly.

The two authors have included most of the systems or schemes of land classification relating to agricultural use that have been described in the literature both in the United States and in other countries. Both discuss the United States soil survey and its productivity ratings; Veatch's land-type classification in Michigan; the economic land classification of A. B. Lewis in New York; the system of Stamp, based on the land-utilization survey of Britain; the Storie index and the German soil ratings for land assessment. Jacks discusses also the land-use capability classification of the United States Soil Conservation Service; the unit-area method of Hudson in the Tennessee Valley; classifications according to agricultural value used in Prussia, Canada, and New Zealand; and the United States Bureau of Reclamation classification for irrigation. Van Aartsen covers the classification for land assessment of Kellogg and Ableiter, Hunkeler's classification in Switzerland, and that of the Danish Health Society. Neither author attempts a critical appraisal of the schemes reported, no doubt realizing the difficulty of judging them solely from descriptions.

Mr. Jacks seems to recognize the important foundation for subsequent land-use classifications that is afforded by a basic classification of land in which the classes are defined in physical terms (soil, relief, and climate). When once bodies of land having uniformity in these characteristics have been mapped and placed in physically defined classes, they can be grouped in many ways to meet the problems at hand.

Also in the *International Review of Agriculture* for 1944, Valentino Dore describes (Classification of the Territorial Area of the Different Countries from the Point of View of Agriculture, pp. 1S–13S) the effort to obtain, for statistical reporting, a standard classification of the land areas of the different countries in terms of kinds of agricultural use. The classification was proposed by the International Institute of Agriculture thirty years ago and was adopted by some countries. The final product consists of tables showing the area of each country in arable land, permanent meadows and pasture, woods and forest land, and so on. It thus deals with the inventory aspect of land classification and shows no concern over the method by which the country might ascertain how much of its land area falls in each of the different classes. The author apparently presumes that the national agricultural censuses will furnish the inventory. This might be feasible in the smaller, more intensively developed countries, but in the United States, and no doubt in other countries, the census affords no means of classifying the large area not in farms. One wonders, too, just how useful these statistics will be, considering the enormous range of things that can be included in each of the proposed use classes.—C. P. Barnes

APPLIED CLIMATOLOGY. The use of climatology in the solution of practical problems in such fields as business, agriculture, building construction, and road construction and maintenance is by no means new (for summaries of such applications see Hans F. Winter-

korn: Climate and Highways, *Amer. Geophys. Union Trans. of 1944,* Part 3, Washington, 1945, pp. 405–411; Eugene Van Cleef: Climate and Business, *ibid.*, pp. 418–420).

Before the war, however, climatological data were generally presented in terms of mean values and independent frequencies of occurrence of the various weather elements. For military planning such generalizations were inadequate (see Charles F. Sarle: Applications of Climatology to Building Construction and Agriculture, *Bull. Amer. Meteorol. Soc.*, Vol. 27, 1946, pp. 210–215; Woodrow C. Jacobs: Synoptic Climatology, *ibid.*, pp. 306–311). It became necessary to know also "duration frequencies, coincident frequencies of two or more elements at the same point, or of the same element at two or more points, or the combination of elements at several points" (Sarle).

The derivation of such statistics requires the entry of available climatic data on punched cards, so that they can be analyzed and summarized by international business machines. Use of such methods, introduced by the Weather Bureau in the 1930's, was much stimulated by wartime needs and must be extended if climatology is to be of maximum service in peacetime in such activities as agriculture, the construction of buildings and airports, the designing of aircraft, the planning of transportation, merchandising, packaging, and advertising. Sarle points out, for example, that the home builder needs the facts about his local climate "not in the form of averages, but as charts and diagrams showing the frequency of occurrence of low and high temperatures, wind velocities, rainfall, depth of snow, etc., and combination and duration frequencies of these elements. For example, a low temperature of say zero degrees is one thing, but when such a temperature is accompanied by winds of 12 miles per hour, the heat loss is increased by 300 per cent." The farmer needs to know the frequency of occurrence of the different weather elements by soil-type areas. This knowledge would make possible not only the choice of crops best suited to both soil and climate but also the choice of the combination of crops that would permit full use of land, labor, and equipment throughout the year.

As Arthur Geddes has expressed it (Planning and Climate: Climates of Region, Locality and Site, and Factors in Lay-out, *Assn. for Planning and Regional Reconstruction Rept. No. 38,* January, 1946), climatic data may be required on three scales: in terms of the region, the district or locality, and the site. Regional climatology, generalized from observations at a relatively limited number of places, is well known for most parts of the world. A recent contribution on this scale is "Europe: Selected Climatic Factors Relevant to Structural and Insulation Requirements for Houses" (prepared by the Research Maps Office, Ministry of Town and Country Planning, for the Inter-Allied Committee for Physical Planning and Reconstruction, January, 1946). This is a series of 10 maps of Europe, with accompanying notes, showing various temperature relationships, the occurrence of gales, snow conditions, depth of frost penetration, and an assessment of annual domestic-fuel requirements. However, equipped only with a knowledge of regional climatology, "planners of town and country . . . are much in the position with regard to local and site climates that they would be with regard to ground features, if they could only avail themselves of atlas maps of relief, etc." and lacked detailed topographic maps (Geddes). Effective planning for communities and homes requires also a knowledge of the climate of locality and site. Many additional points of observation are, of course, necessary for the development of such local climatology.

OBITUARY

RECENT LOSSES TO BRITISH GEOGRAPHY. Britain has recently lost five men who in varying degree and kind have made important contributions to geography: Sir Halford J. Mackinder (1861–1947), Professor P. M. Roxby (1880–1947), Professor L. W. Lyde (1863–1947), Mr. H. J. E. Peake (1867–1946), and Brigadier H. St. J. L. Winterbotham (1878–1946).

Halford John Mackinder has been the Grand Old Man of British geography for the past twenty-five years. Increasing age and deafness had forced him into retirement, so that few of the younger generation knew him personally. But events of World War II, and some of its first results, are so nearly in accord with certain of the forecasts he made from 1904 to 1919 that his name has never been more widely known than in the last four or five years. Among recent honors that came to him was the Charles P. Daly Medal of the American Geographical Society, 1944.

When the modern revival of geographical studies in British universities was initiated, Mackinder was appointed to a readership in geography at the University of Oxford, "the only previous holder of such a post having been Richard Hakluyt in the reign of Queen Elizabeth" (*Nature*, April 19, 1947, p. 530). He often related that the audience at the first lecture of his first course numbered five persons, of whom two were elderly ladies who had brought their knitting. From that start he built up the Oxford School of Geography. As it grew, he drew in able young men from outside, and it became the leading school of geography in the English-speaking world.

Two of Mackinder's favorite sayings, often repeated in his lectures, come to mind as expressive of his outlook. One is: "Every event takes place both in space and in time, so it has both a geographical and a historical aspect." The other is that one of his aims was to "think through history on the map." These sayings reflect his early training in history and the outlook that led to the most important of his later work—the development of his views on the age-old contrast and conflicts between the Heartland and the Coastlands of the Old World.

He was also concerned with other aspects of geography. His "Britain and the British Seas" (1902) is a classic regional study. It was the first, and it became the best known, of the series that he edited as "The Regions of the World." The inadequacy of the teaching of geography in the schools of the time directed his attention toward the production of school texts in the combined study of geography and history.

But he was not only a student of "history on the map"; he was also an administrator and an active participant in politics. He was principal of the University College of Reading from 1892 to 1903, simultaneously holding office in the oldest and one of the youngest of English universities. Later he became director of the London School of Economics and Political Science, and still later chairman of the Imperial Shipping Committee and the Imperial Economic Committee. Geographers will also recall that he made the first ascent of Mount Kenya. His success in these posts and activities is evidence of his amazing versatility, and also of the energetic and sympathetic personality that made friends and helpers of all those with whom he worked.

The paper on "The Geographical Pivot of History," read to the Royal Geographical Society in 1904, did not attract any great notice. The concept of the differences between

Heartland and Coastland, the regions accessible to Horsemen and Shipmen respectively, and the conflicts between their peoples was further developed in his book "Democratic Ideals and Reality" (1919) after World War I (discussed in the *Geographical Review* by F. J. Teggart, Vol. 8, 1919, pp. 227–242, and C. R. Dryer, Vol. 9, 1920, pp. 205–207). That book fell flat among the Englishry. It was, however, promptly translated into German and passed through many editions in that language. Its influence in Germany was such that he has been called the "Father of Geopolitik," though he condemned the policies of that school. His aim was to urge the peoples of the democracies to recognize that the growth of peoples and states takes place on the earth; that it can be guided wisely only by men who understand the geographical basis of our life, and this only if such leaders are backed by a public opinion which is itself based on an intelligent appreciation of the main facts of geography. He believed and taught that it is impossible to attain the ideal of a "world safe for democracy" unless we take full and just account of the geographical realities. That message is still of value to the world.

Percy Maude Roxby was, like Mackinder, a history student of Christ Church, Oxford. He passed thence into the School of Geography under its second head, Professor A. J. Herbertson, who had followed Mackinder. He was subsequently appointed lecturer in geography in the University of Liverpool, and there he worked from 1904 to 1945 and made a lasting impress on the development of the university and on many generations of its students.

Roxby had a strong personality, wide sympathies, astounding energy, and entirely unselfish enthusiasms, and he gave himself wholeheartedly to the service of his students and his fellow men. His interests in geography and in social welfare combined to make him one of the initiators and ardent supporters of the Survey of Merseyside, a pioneer cooperative work that has been of great value in the modern movement of town-and-country planning. It also helped in the training of many of his students. The Chinatown of Liverpool led him to an interest in China. He visited that country several times. There, as everywhere, he made many friends, and his work contributed to build a bridge of sympathy and understanding between Britain and China. He died in harness there, his death doubtless accelerated by the hardships of life in a war-ravaged land and his self-sacrificing urge to help its people. It is an irreparable loss to the science of geography and to scholarship that he did not complete the work on the geography of China, which he of all men was best qualified to write. A few published papers are evidence of the range and quality of that work; for example, "The Distribution of Population in China" (*Geogr. Rev.*, Vol. 15, 1925, pp. 1–24).

To those who knew this lovable man the sense of personal loss is profound; but if our professional ranks are poorer, we are richer for the inspiration he has left to us.

Lionel William Lyde was a classical student at Oxford and later learned geography by teaching it. He was professor of geography in University College, London, from 1903 to 1928; and in the early years of this century his school texts were widely used in England and did much to aid the spread of geography in schools. His knowledge of his subject was almost encyclopedic, and he had great skill in presentation. He was a vivid and stimulating lecturer. At the afternoon meetings of the Royal Geographical Society he was long active. There he delighted to "trail his coat" by making startling and provocative assertions. And his factual knowledge was so wide and accurate that he could, when challenged, produce evidence in support of his most challenging statements. But it was as a teacher that he did his best work, and he will be long remembered by his many students.

Harold J. E. Peake was the squire of Boxford, near Newbury, in the Berkshire Downs of England. He grew up in an area rich in remains of prehistoric man and his cultures; and there he became a student of early man. He worked as an amateur, without professional or academic status or recognition, but he judged his work by the strictest professional standards.

Probably his chief contribution to knowledge was made by his researches into the Bronze Age culture and its spread and distribution in Britain and Western Europe. On this he became a leading authority. His investigation of this early culture was the starting point for his book "The English Village," which traces the development of that type of settlement from its prehistoric origins down to the present day. He also made a valuable contribution to education by his reorganization of the small local museum at Newbury to illustrate the development of human cultures through the ages. In this work he was a pioneer; and his museum became an example and a stimulus to the movement that has transformed our museums from the dusty collections of curios some of us can remember to lively tools for the education of the citizen of the world. He will also be remembered for "The Corridors of Time" (jointly with Professor H. J. Fleure), which has for so many readers blazed a clear trail through the dim vistas of prehistory. Readers of the *Geographical Review* will recall his "The Origin and Early Spread of Ironworking" (Vol. 23, 1933, pp. 639–652) and "An Ancient Trackway on the English Downs" (Vol. 29, 1939, pp. 431–446).

Harold St. J. L. Winterbotham was a regular officer of the Royal Engineers. He served with distinction in many parts of the world, specializing in the Survey Section.

He is best known to geographers for his work at the Ordnance Survey, where as director-general his activities included the production of the fifth (relief) edition of the one-inch topographic map of Great Britain. The production was stopped soon after his retirement, before the outbreak of World War II, and the subsequent rush of events has caused the map to be superseded. The published sheets represent one of the highest achievements of artistic cartography and will long be prized by students and connoisseurs of map making.

After his retirement Brigadier Winterbotham wrote a popular book on maps and map production, "A Key to Maps" (1936). He was a genial and friendly person, who did much to develop and maintain the tradition of friendly cooperation between the survey departments and geographers.—Charles B. Fawcett

JACQUES WEULERSSE. Jacques Weulersse, professor of colonial geography at the University of Aix-Marseille (France), died at Dakar on August 28, 1946, at the age of 41. One of the most brilliant students of Demangeon, he leaves an impressive number of publications, mostly on Africa and the Near East. After traveling widely through Africa, the Far East, and the United States, he studied the Near East from 1932 to 1938 as a member of the French Institute in Damascus and revisited the Levant in 1945–1946. He was one of the French experts of the Allied commission that worked on the Italo-Yugoslav boundary and Trieste problems. His book "Black Africa" (1934) had already become a standard work in France, and he was returning to his African research when his career was cut short. He published a number of important articles on the Arab countries; and his recent book on the land of the Alawi in Syria and the posthumously published "Paysans de Syrie et du Proche-Orient" are discussed in this number of the *Geographical Review*.—Jean Gottmann

REPORT OF THE FAO MISSION FOR GREECE. xi and 188 pp.; maps, ills., index. Food and Agriculture Organization of the United Nations, Washington, D. C., March 1947. 10¾ x 8¼ inches.

The Food and Agriculture Organization's Mission for Greece was set up in the spring of 1946 by request of the Greek government, and its members spent several months in Greece between May and August of that year. Their final report is a lucid, readable, and concise picture of what they saw and what they believe to be necessary for the reconstruction of a country severely damaged by World War II.

The report is divided into two main sections. In the first section the major recommendations of the Mission are listed and briefly explained in terms of the present situation and of immediate and long-range objectives. The second section consists of a series of appendixes dealing with specific problems, offering detailed suggestions, and documenting them with such statistics as are at present available. The first section, after outlining some of the principal problems of immediate and transitional importance, such as railroad reconstruction, control of inflation, and restoration of export markets, proceeds to discuss in some detail the utilization of water. "The development of water potentialities and the control of water will contribute more wealth to the nation, and assist far more in raising the standard of living of millions of people in Greece, than any other natural-resource development." The Mission recommends the preparation of a plan for both desirable and feasible, immediate and long-range, projects of the multiple-purpose type designed to check soil erosion, increase drainage of marshy areas, improve flood control, and generate hydroelectric power. In the rough estimate presented it is stated that "the total cost of constructing the projects which can be completed in the next five years . . . is estimated at 36 million U. S. dollars of prewar purchasing power, while full development of all projects would cost an additional 215 million dollars over the next two or three decades." The potential irrigated area that could be brought under cultivation through these projects equals roughly one-fifth of the total cultivable area of Greece, or some 1,750,000 acres; and a preliminary estimate of hydro-electric-power production, assuming full utilization of available resources, puts it at five billion kilowatt-hours a year, nearly the equivalent of the annual output of Boulder Dam. In addition to direct benefits in electric power, erosion control, flood prevention, and the like, the production of fertilizers by the electrical process would be a valuable help to the relatively poor soils of the country.

Among the long-range objectives for agricultural development, recommendations of the Mission include larger output per farm family, greater opportunities for nonfarm employment, extensive reorganization of governmental agencies concerned with agriculture, concentration and intensification of agricultural research, soil conservation with special emphasis on the dangers of strip farming as now practiced in many areas of Greece, and increased emphasis on agricultural education (both in the universities and colleges and in the secondary schools) and on agricultural guidance services, such as demonstration farming, publication of information on improved techniques, distribution of improved livestock, and provision of free veterinary services.

Among the economic measures to improve agriculture the Mission places increased support of cooperatives in a leading position. Since many features of agricultural recon-

struction are common to all the lands of Eastern and Southern Europe, it may be of interest to quote at some length the measures recommended. "It is recommended that the co-operatives and co-operative unions be assisted (a) to extend production credit to farmers through local village co-operatives; (b) to make long-term loans to farmers for the purchase of pumps, animals, barns, tractors, drills, and other essential productive equipment; (c) to purchase tractors, threshing machines, power sprayers . . . and other large equipment for operation by village co-operatives or co-operative unions; (d) to make village improvements, such as small irrigation or hydroelectric developments or domestic water supplies; (e) to provide facilities for the co-operative merchandising or processing of farm products; (f) to provide facilities for local industries for the processing of farm materials or of products needed by farmers; and (g) to provide facilities for the purchase, importation, and distribution of farm and family supplies to farmers, and of consumers' goods to members of urban consumers' co-operatives." The Mission takes stand, however, against compulsory membership in cooperatives and recommends that these organizations compete with private industries rather than be given exclusive rights of buying and selling farm and industrial products.

The Mission recommends that the program be carried out only gradually, since the resources of Greece, even if assisted by foreign loans, could not undertake so comprehensive a development all at once. Concerning this last point, international financial aid, the Mission finds "that Greece will need an initial international loan for 1947–48 of at least 100 million dollars if she is to begin the reconstruction and development program recommended by the Mission."

The recommendations are buttressed by nine appendixes, which describe in detail present conditions and recommended measures in the following fields: water resources and development; livestock and livestock products; crop husbandry; soil fertility; seed production; phytopathological service; fisheries; general principles of agricultural development; economic problems. A series of tables, 45 photographs, and a map showing proposed hydroelectric developments contribute to the well-founded character of the report. At a time when the affairs of the eastern Mediterranean are of immediate concern to the world, the publication of such a report, with its emphasis on the fundamental issues instead of on superficial trends, its ample documentation, and the competent, clear, and calm approach it brings to a controversial problem should be hailed as a significant step forward on the road to true international cooperation.—George Kiss

BRITAIN'S STRUCTURE AND SCENERY. By L. Dudley Stamp. xvi and 255 pp.; maps, diagrs., ills., bibliogr., index. (The New Naturalist: A Survey of British Natural History [No. 4].) Collins, London, 1946. 16s. 8¾ x 6 inches.

THE COASTLINE OF ENGLAND & WALES. By J. A. Steers. xix and 644 pp.; maps, diagrs., ills., index. Cambridge University Press, Cambridge, England, 1946. 42s. ($9.50, The Macmillan Co., New York). 9½ x 6¼ inches.

"Britain's Structure and Scenery" might almost be described as a textbook in geology and geomorphology with examples from Britain; for that small island is "in many respects a museum model illustrating the evolution of the world as a whole." Specifically, the volume is intended as background for a series of natural-history studies for the general reader. That

Professor Stamp has succeeded may be gathered from the reception accorded his book. It "can be recommended to every beginner who is prepared to take some trouble," says the literary editor of the *New Statesman and Nation* (Oct. 26, 1946). "Some trouble" is necessary; for the formidable task of compressing so enormous an amount of technical material has not made for light reading, though the reader is greatly assisted by the author's lucid and agreeable style and by the admirable illustrations—careful maps and diagrams and numerous photographs from the ground, many of them in color, and from the air.

The first three-quarters of the book is devoted to exposition of structure and process, with ample regional illustration. There is a long chapter on geographical evolution, with a series of paleogeographical maps from the Cambrian on; chapters on the work of rivers and of the sea, on the scenery of the sedimentary rocks, of limestones and volcanics, and of glaciation; and a chapter on soils, in which the lack of soil maps for most British counties is explained. Regional description occupies one-quarter of the book. The divisions south of the Border are the London and Hampshire Basins, the Weald, East Anglia and the Fens, the Scarplands, the Midlands, the Southwest, the Welsh Massif (including also Monmouthshire, Herefordshire, and part of Shropshire), and the North of England (the Lakes and the Pennines). The author dwells lovingly on the Weald, "one of the most fascinating geological regions of all Europe," giving it as much space as Scotland and more than that allotted to Ireland, but the brief treatment of these two countries is to be compensated by special volumes in the series. Perhaps a little too much credit is given the Weald as "classic" ground in W. M. Davis' concept of river evolution. [Just what part was played by various regions it is difficult to say; Professor Stamp thinks Davis must certainly have been influenced by William Topley's "classic" Wealden studies.]

When the reader has come to the end of the book, he might well turn back to the invitation given in the introduction—the exploration of what is still to a surprising degree a *terra incognita* even to the well-traveled minority of the kingdom's 45 million inhabitants. "There are whole counties so far off the beaten track that not a man in a thousand has visited them or knows anything of the conditions of life in them . . . There are many areas where the vegetation has never been mapped or described, where the changing balance of plant and animal life is waiting to be observed and recorded for the first time and where the explanation of observed changes is still a matter of guesswork. Some of the unexplained features are matters of the highest economic importance—the changing character of hill pastures, the new plant relationships created by afforestation and the introduction of foreign trees are some that spring to mind."

"The Coastline of England & Wales" is a detailed treatment of one of the multifarious aspects of Britain's scenery. It is a physiography on regional lines. The bulk of the book—eight chapters—takes up the major divisions in sequence from Solway Firth to Berwick-on-Tweed. Three introductory chapters give a general statement, a summary of the physiographic history of the land in its bearing on coastal evolution, and a brief examination of shore processes, in which Mr. Steers acknowledges a debt to Douglas Johnson's "Shore Processes and Shoreline Development," the "first comprehensive book on the subject." Three concluding chapters return to general discussion in the themes of vertical movements of the coast, sand dunes, and salt marshes.

Two outstanding features of the book are emphasis on "the inter-relations of the work of many sciences in the interpretation of coastal features" and a cautious attitude toward

generalization in interpretation. The former is exemplified in the attention paid to vegetation succession—for instance, in Mr. Steers's own Scolt Head Island studies—and in the use of archeological evidence, as in the discussion of the lost towns of Holderness and the Sarns, the natural causeways in the legendary lost land of Cardigan Bay. Because of its wide applicability an example of the second point is quoted: "the probable effects of the Ice Age on changes of sea level. These changes are revealed in such phenomena as river terraces, raised beaches, and submerged forests, but, at present, a complete understanding of them is lacking. The whole subject is one of great difficulty, and much that has been written on it may mislead because of premature attempts to generalize and correlate which are, as yet, unjustified. . . . For post-Glacial, and more particularly late post-Glacial, changes the technique of pollen analysis has helped greatly, but it has not necessarily simplified the problem" (p. 475). Another distinguishing feature of the book is the documentary aid in the form of 114 maps and diagrams, 115 photographs, and 2 color plates, all excellent.

This richly suggestive contribution to a not abundant literature merits detailed review by a physiographer; here it is noticed mainly in relation to its further purpose—to "serve as a geographical background to the assessment of coastal scenery, and so to the proper use and enjoyment of our coasts." The book finally took shape in response to a request from the Ministry of Town and Country Planning, as is indicated in the introductory notes by Professor Stamp and Sir Patrick Abercrombie: "This study of the coast leads inevitably and without a break to its practical application in use." Mr. Steers himself has enlarged on the planning aspect in two articles in the *Geographical Journal* on "Coastal Preservation and Planning" (July–Aug., 1944, and Jan.–Feb., 1946), accompanied by maps that together present an analysis of the entire coast of England and Wales in terms of quality of scenery and coastal development (scale 1 : 1,500,000).

FORESTS AND FORESTRY IN GREAT BRITAIN. By WILLIAM LING TAYLOR. x and 172 pp.; ills., index. Crosby Lockwood & Son, London, 1946 (1945, reprinted 1946). 12s. 6d. 8¾ x 5½ inches.

The significance of forests and forestry in the national economy of a country becomes particularly apparent in time of war. This has been especially true in Great Britain, where the realization is growing that a serious effort must be made to provide resources *within the country* if the safety of that island realm is to be ensured. "Forests and Forestry in Great Britain" was evidently written to stimulate broader and deeper interest in British forests from this viewpoint, and to acquaint the British people with the bearing that national forest policy has on national welfare. These objectives should be attained if this book receives the wide reading it deserves.

After a brief but fascinating history of Britain's trees and forests the author attempts to provide an outline of what forestry is, defining it as "the art of growing rotational crops of timber trees in forests and woods." It is estimated that there are in Britain at least 4½ million acres of land, now bearing only heather, rough grasses, and ferns, that are suitable for forest production. This fact together with excessive cutting and neglect of existing forests during the war years accounts for the attention currently being directed to afforestation and reforestation. Exotic species, including several from America, have been employed successfully in developing new forests.

The benefits derived from forests are many. The author makes it clear that in addition to supplying such obvious products as mining timbers, boards, heavy bridge timbers, and

cellulose, forests exercise a beneficent influence on the water regime, soil conservation, and wildlife.

What of the future? If reforestation and afforestation measures now under consideration are carried out, the British may ultimately be able to grow about 40 per cent of the timber they require. The rest will have to be imported. Inasmuch as many of the countries of the world are in need of more timber than they can produce, it seems clear that competition in the timber markets will not be lacking.

Excellent full-page plates illustrate the text of this most useful book.—H. J. LUTZ

LES FORÊTS COLONIALES DE LA FRANCE. By LOUIS LAVAUDEN. Maps, diagrs., bibliogr. *Rev. de Botanique Appliquée et d'Agric. Tropicale,* Vol. 21, 1941, pp. 285–365, 509–622, and 671–752.

This treatise was originally written in 1935, shortly before the author's untimely death. His relatively brief but active career was spent in the Service des Eaux et Forêts, largely in the French possessions of North Africa, West Africa, and Madagascar, and he was obviously a man of broad interests and deep insight into the problems and possibilities of the African continent. The regions with which he was familiar are covered in detail; other regions are dealt with only in very general terms.

The first part, entitled "Actual Condition of the Forests in the Principal Groups of Colonies," is perhaps the one of most general appeal. Chapter titles and contents are as follows: 1, "The Forests of North Africa," dealing in turn with the forests of cork oak, *zâne* and *afarès* oak, "green" oak (*Quercus ilex*), elm and ash, Aleppo pine, maritime pine, *thuya* (*Callitris articulata*) and the junipers, and, finally, the true cedars. 2, "The Dry Forests of the Sahara and the Sudan"; this region is divided into four relatively narrow east-west zones, namely the north edge of the Sahara, the central Sahara, the Sahel, and the Sudan. 3, "The Equatorial African Forest." 4, "The Mangrove." 5, "The Forests of Madagascar." 6, "The Forests of Indochina." 7, "The Forests of [French] Guiana."

In the same order the second part treats of the "causes of destruction and . . . permanent enemies" of these forests. The third part discusses future policies and measures for protection, exploitation, and re-establishment of the various forests of French Africa. The fourth part describes the many valuable products that the forests of the French colonies could furnish. In addition to lumber and other wood products, chemicals and pharmaceuticals, gums and resins, food products, camphor, raffia, and pigments are enumerated.

In the fifth part, entitled "The Struggle against the Invasion of the Desert," Lavauden cites evidence from many parts of Africa that supplies of surface and subterranean water have decreased alarmingly during historical time. He indicates a belief that any theory of broad decrease in rainfall over a period geologically so short is not wholly tenable. Only occasionally does he revert to the fallacy, once common among foresters, that forests have a significant beneficial influence on the climate of places outside their limits. However, his emphasis on the effects of forest cover on stream flow and microclimatic conditions within the forest itself is well placed. He points out, again and again, that in dry or equatorial climates, such as those found in Africa, the forest is a fragile thing, which, once removed, may require a long time, even centuries, to reclaim its place by means of plant succession. In the drier regions, overcutting, fire, and excessive grazing have eventually eliminated forests over thousands of square miles, converting areas that supported nearly forgotten

Mediterranean and Negro civilizations into arid brushlands. Lavauden declares that the luxuriant equatorial forest, contrary to popular belief, is inferior in richness and productivity to temperate forests and is, furthermore, extremely susceptible to destruction as a result of unwise management. It is supported solely by the thin layer of humus on top of the mineral soil; when the forest is removed, this layer quickly decomposes under the extreme insolation.

The sixth part of the article deals with recommendations for reforestation of the various regions. The seventh part, "Propaganda," discusses measures that might be employed to alter the attitude of natives, as well as of colonists, toward the forests.—DAVID M. SMITH

LES PAYS TROPICAUX: Principes d'une géographie humaine et économique. By PIERRE GOUROU. viii and 199 pp.; maps, indexes. (Colonies et Empires, Ser. 1, Études Coloniales, 3.) Presses Universitaires de France, Paris, 1947. 180 fr. 9 x 5½ inches.

LE MONDE MALAIS: Péninsule malaise, Sumatra, Java, Bornéo, Célèbes, Bali et les petites îles de la Sonde, Moluques, Philippines. By CHARLES ROBEQUAIN. 510 pp.; maps, diagrs., ills., bibliogr., index. (Bibliothèque Géographique.) Payot, Paris, 1946. 440 fr. 9 x 5½ inches.

THE EVOLUTION OF THE NETHERLANDS INDIES ECONOMY. By J. H. BOEKE. x and 180 pp.; index. (I.P.R. International Research Series.) Netherlands and Netherlands Indies Council, Institute of Pacific Relations, New York, 1946. $2.00. 9 x 6 inches.

"Les pays tropicaux" is a most interesting and important work. Gourou's book is the first one known to the reviewer that summarizes successfully the relations between man and his environment in those usually misunderstood and misinterpreted regions. It is a thrilling book for a student of land use in the tropics. Gourou shows that the very low density of human and domestic-animal population in most of the humid tropical regions is due to the unhealthfulness of the climate and the poverty of the soils and, consequently, of the pastures. He points out that the usual annual upland food crops cannot be grown year after year on these soils without the use of fertilizers. He describes at some length the method of land use he terms "ray" (the same as the Siamese *rai*), which is known in the literature on Philippine agriculture as "kaingining." As Gourou sets forth in detail, this is a long-time rotation, in which the forest cover crop restores soil fertility and eliminates weeds. The method needs perhaps ten times the area of land to support a family by the most intensive methods.

Although Gourou mentions cogon (*Imperata cylindrica*) and related grasses, he does not seem to be aware of the much worse characteristics of the Asiatic species as compared with the species native to the Western Hemisphere. Neither do the overzealous soil-conservation and pasture specialists in the Gulf and Caribbean regions who have committed the very serious error of introducing cogon into Florida and Puerto Rico. As Gourou states, the most important difference between the Asiatic and the American humid tropics is that in Asia lowland rice is grown even on the poorest soils. This crop is unique in that it will produce reasonably well year after year on the same soil without artificial fertilizers, the only requirement being that the land be kept flooded to at least a slight depth with irrigation water during the growth of the rice. Enthusiastic advocates of the industrialization of tropical regions would do well to consider the factors Gourou gives that will continue to retard such development: lack of power and raw materials, difficult working conditions, and limited markets. The author's contrast of the attitudes and policies of the different European governments toward colonial and agricultural peoples is illuminating and sobering.

"Le monde malais," inspired by a trip made by Robequain in 1938, essays to present the geography and colonial economy of this part of Southeast Asia conceived as a unit. The first and second parts deal in a more or less conventional way with the geography of Malaya, Sumatra, Java, Borneo, Celebes, the eastern Netherlands Indies, and the Philippines. Part 3 describes the differences in impact of the colonizing powers, particularly Britain, the Netherlands, Spain, and the United States, on the peoples of the region and emphasizes the effects of the capitalistic plantation system and the application of science to the production of tropical commodities. The interrelationships of the plantation system, and the native agriculture and its gradual improvement, are also considered. Part 4 deals with the effects brought about by medicine and hygiene, evangelization by Christian missionaries, education of the natives, and political evolution. In conclusion, the destiny of a Malay world is discussed, in relation both to the European colonizing powers and to Japan and the United States. A useful bibliography of 255 titles is included.

"The Evolution of the Netherlands Indies Economy" was written by Professor Boeke during his internment in World War II. His book is characterized by Frans H. Visman in the foreword: "Its subject matter ranges from a historical retrospect upon the forces that have shaped the economic policies of the Netherlands Indies Government to recent changes in the agrarian, trade, and labor policies of both Government and private enterprise. Its special significance lies in the intimate manner in which the author connects basic factors in the support of the colony's economic structure with a vital concern in the ever changing influences that determine the welfare of every section of the population. To those who are in the habit of regarding the statistics of foreign trade, of investment, and of government revenues as sufficient indications of the territory's prosperity or the lack of it, and to those who tend to discuss the burning social and political questions that agitate the Indies as though they were unrelated to questions of world trade, of public finance, or of the social composition of the population—to all such this book may be recommended as holding up the mirror to a reality that is far from simple or easy to appraise."

The feeling with which one closes the book is that once government endeavors to direct, control, and help, there is no turning back and no end to the restrictive, controlling, and directing measures which are felt to be necessary, particularly when the exploitation, however benign, is by a Western nation of an Oriental people having entirely different concepts and values of property, landownership, and trade.—ROBERT L. PENDLETON

AN ATTEMPTED POST-TERTIARY CHRONOLOGY FOR AUSTRALIA. By W. R. BROWNE. Maps, bibliogr. *Proc. Linnean Soc. of New South Wales*, Nos. 317–318, Vol. 70, Parts 1–2, 1945, pp. v–xxiv.

THE RELATIONSHIP OF THE AUSTRALIAN CONTINENT TO THE PACIFIC OCEAN—NOW AND IN THE PAST. By W. H. BRYAN. Map, bibliogr. *Journ. and Proc. Royal Soc. of New South Wales for 1944*, Vol. 78, Parts 1–2, 1945, pp. 42–62.

LATE GEOLOGIC HISTORY OF THE PACIFIC BASIN. By HAROLD T. STEARNS. Map, diagr., bibliogr. *Amer. Journ. of Sci.*, Vol. 243, 1945, pp. 614–626.

Scientific interest in the vast Pacific region has been powerfully stimulated as a result of activities during World War II. Islands and island groups that formerly were mere names have become familiar geographic entities, and attention has been focused on geologic and topographic features that provide clues to both local and regional history in late geologic

time. Australia, the chief land mass, is a suitable point of departure in a general survey. Dr. Browne gives a useful summary of Pleistocene and Recent geology in this smallest of the continents. Two distinct glacial stages, recognized both in Tasmania and in the Kosciusko area of New South Wales, are correlated tentatively with the Riss and Würm stages of Europe. The earlier of the glaciations was almost contemporaneous with an important crustal movement that resulted in a broad arching upwarp athwart the south-flowing streams of central Australia. Since the glacial climate was marked by increased humidity over most of the continental area, a great fresh-water lake formed behind the tectonic barrier. Other lakes and numerous swamps of the Pleistocene epoch have left clear records in sedimentary deposits. The larger and more numerous streams of glacial times also are recorded in characteristic deposits and landforms. Movements of the strandline occurred in response to waxing and waning of ice sheets; in particular, a higher sea level, supposedly during the long Mindel-Riss interglacial interval, is recorded widely in terraces at altitudes above 100 feet. Extreme aridity characterized the early part of the Recent epoch, evidenced by the large areas of sand ridges extending eastward into Queensland. Many forms of life that had flourished during the Pleistocene, including marsupials and great flightless birds, became extinct. These and other high points in post-Tertiary history are listed by Dr. Browne in a convenient table—avowedly tentative in part—as a supplement to his lucid discussion.

W. H. Bryan, in his stimulating article, gives arguments for the existence, up to early Tertiary time, of a greater Australian continent that extended to the "Marshall Line," as much as 2000 miles east of the present eastern shore line. This line is the real southwestern boundary of the Pacific basin, floored with basaltic rock. The submerged area of the former continent is dotted with numerous islands characterized by sialic bedrock and contains extensive shoals. This area, three million square miles in extent, is not properly considered as the "ricketty front porch of an otherwise well constructed house." The submerged part of the continental mass is in fact stable, as is indicated by its freedom from earthquakes except near its outer margin.

Stearns undertakes a general outline of late geologic history in the entire Pacific basin, the western boundary of which is placed at the "Sial line," extending northward from New Zealand and Tonga between the Marshalls and the Carolines, and east of the Marianas and Japan. In its southern part this is essentially the "Marshall Line" of Bryan. The chief events listed in Stearns's outline are: (1) eruption of basalt in great quantities during Neogene time, forming thousands of volcanic islands, widely distributed; (2) deep dissection of the higher islands by streams; (3) great subsidence of the Pacific floor at the end of the Pliocene epoch, causing deep drowning and alluviation of valleys; development of coral reefs to great thicknesses during the subsidence; (4) rapid emergence, by as much as 1000 feet, in early Pleistocene time; (5) eustatic fluctuations of sea level in response to glaciation and deglaciation. Stearns's brief paper is little more than a statement of conclusions, which will require extensive documentation for complete acceptance. The Pacific floor is generally recognized as a unique lithologic and tectonic unit. Has the remarkable uniformity of behavior outlined by Stearns for late Cenozoic time characterized this unit through its long history? If so, the implications are very important indeed. Some of Stearns's suggested interpretations seem questionable. For example, it is hardly conceivable that vast piles of basaltic lavas, built upon the ocean floor by transfer from underlying reservoirs, could exist as an unadjusted load during one or more geologic epochs, with eventual isostatic adjustment recorded in major subsidence during a brief time interval. What is important,

however, is factual evidence of what occurred, not speculation on the mechanisms involved. Stearns's paper gives a glimpse of a magnificent frontier in geologic and geophysical research.

Many geologists and other scientists went into the Pacific during the war, and some are still there, with unrivaled opportunity for new observations and correlations. New stores of information and many stimulating ideas may be expected to result directly from this aspect of the war effort. Better still, the interest aroused by the discoveries will lead many in addition to those in this first wave of scientific invaders to move into the enticing fields of conquest. Perhaps we are on the threshold of a new era in Pacific research.—CHESTER R. LONGWELL

GEOLOGY OF THE HAWAIIAN ISLANDS. By HAROLD T. STEARNS. v and 106 pp.; maps, diagrs., ills., bibliogr., index. *Territory of Hawaii Div. of Hydrogr. Bull. 8,* 1946.

GEOLOGY AND GROUND-WATER RESOURCES OF THE ISLAND OF HAWAII. By HAROLD T. STEARNS and GORDON A. MACDONALD. xiii and 363 pp.; maps, diagrs., ills., index. *Ibid., 9,* 1946.

These two beautifully illustrated and printed publications are a noteworthy addition to the descriptive and technical literature on Hawaii. They have been preceded by a geological map and guide of Oahu and bulletins (some are now out of print) on the geology and ground-water resources of the islands of Oahu, Lanai and Kahoolawe, and Maui prepared entirely or in part by H. T. Stearns of the United States Geological Survey and issued by the Division of Hydrography of the Territory of Hawaii.

The "Geology of the Hawaiian Islands" is a popular description of the historical geological development of the group. Colored plates show the centers of eruption and the changes in appearance of the resulting islands due to erosion and both emergence and submergence. Twelve terrace levels are recognized, some of which are eustatic. Marine erosion has cut cliffs as much as 3000 feet high on the windward side of volcanic domes. Stream erosion varies greatly, owing in part to differences in rainfall. The remarkable amphitheater-headed valleys resulted from several factors: the original slope, the alternation of resistant and weak beds, usually dipping downstream, the growth of master streams accompanied by stream piracy, undercutting at the plunge pools of waterfalls, landslides, and competency of jointed basalt to resist erosion and form steep cliffs.

Typical stages of Hawaiian volcanoes are described. Above a fissure 1600 miles long, shield-shaped basaltic domes have been built, with vents about 25 miles apart, that rise from ocean depths of nearly three miles to elevations culminating in Mauna Kea, 13,784 feet above sea level, and Mauna Loa, 13,680 feet. After a dome has been built, the volcano usually collapses over the vent area to form a summit caldera. When erosion exceeds the flow of the new lava, canyons and marine cliffs are cut. Late lava flows often fill the caldera and obliterate it. Fissure eruptions on the side of the dome are common. Submergence may partly drown the island, and coral reefs and sediments may be deposited, which are later uplifted. Renewed volcanic activity, often of the cinder-cone type, may occur before the vent becomes extinct.

The volcanoes of the island of Hawaii are considered to have begun their activity in the Tertiary period. Only Mauna Loa, Kilauea, and Hualalai are classified as active. Kohala is extinct. There are numerous volcanic series with a great erosional unconformity near the end of the Pliocene. The rocks of the island are highly permeable, and the rainfall generally

sinks quickly into the ground. Permanent streams on Hawaii are present only on the windward slopes of Mauna Kea and Kohala. Here the rainfall is adequate for sugar cane without irrigation. The development of ground-water supplies on the dry leeward slopes is economically desirable for irrigation, stock water, and domestic use. The rain water usually sinks to the basal water table, where it is perched above salt water and escapes in springs near sea level along the coast. Little is recovered, and along leeward coasts the water may be brackish. High-level water may occur above dense lava flows and impermeable ash beds. Some of these sources supply water to springs and tunnels. It is estimated that an average of 13,085 million gallons of water a day falls on the island of Hawaii, of which only 2.5 per cent is visibly discharged from wells, springs, and tunnels. Hence much ground water awaits development, and several projects are planned.—OTIS W. FREEMAN

LES NOUVELLES HÉBRIDES: Îles de cendre et de corail. By E. AUBERT DE LA RÜE. 253 pp.; maps, ills., bibliogr. (Collection "France Forever.") Les Éditions de l'Arbre, Montreal, 1945. 8 x 5¼ inches.

This little volume on the seldom-heard-from New Hebrides—one of a war-born series designed to keep French culture and scientific thought alive in America during the German occupation—is in the best tradition of French regional geography. The author, whose colonial monographs include earlier works on Kerguelen, French Somaliland, and St. Pierre and Miquelon, records here his geographical observations during 18 months in the New Hebrides in 1934, 1935, and 1936.

Existing literature on the New Hebrides, consisting principally of missionary memoirs and anthropological reports, has largely neglected the physical geography of the islands, and it is here that this volume makes its principal contribution. Especially noteworthy are the descriptions of the two most active volcanoes, on Ambrym and Tanna, both of which the author studied in some detail. There is a surprising abundance of savanna and chaparral-type brush vegetation in the group, especially on the more southern islands, but the extent to which man's actions are responsible is only hinted at. Erromanga, it may surprise American readers to learn, supports a thriving flock of 2000 sheep.

The second half of the book is a well-organized survey of the material culture, attitudes, and social organization of the native Melanesians. The complicated problem of critical culture-element distributions has been largely avoided, however, and no distribution maps are included.

The timely question of the unique British-French condominium rule under which the islands have struggled for 40 years is disappointingly side-stepped. Of some 1000 white settlers in the group today, not one-quarter are British subjects. The numerically and economically dominant French owe their position to lax restrictions, which have permitted the employment of indentured native and Tonkinese labor. The author observes that it is not to France's interest to see England cede to Australia its rights in the New Hebrides, and an alternative proposal for outright partition between the powers is seen as fraught with legal complications.

Large numbers of American, New Zealand, and even native Fijian troops were stationed in the New Hebrides, especially on Espiritu Santo and Efate, during the war years. Analysis of their impact on the native economy will have to await future studies. By 1936 the population had fallen to 40,000 from the one million natives estimated by Harrisson to have

been in the group at the time of the first white contact. Aubert de la Rüe sees the imminent extinction of these primitive islanders and their uniquely preserved Stone Age culture unless remedial measures are at once taken. It is significant, however, that the first indications of a population increase had been observed on some of the smaller islands (for example, Tanna, Tongoa, Paama, and Efate) even before 1941. This suggests that the precipitous decline may yet be checked and even reversed before base level is reached, as has occurred in most other Oceania population groups.—JAMES J. PARSONS

A SCIENTIFIC THEORY OF CULTURE AND OTHER ESSAYS. By BRONISLAW MALINOWSKI. ix and 228 pp.; index. The University of North Carolina Press, Chapel Hill, 1944. $3.00. 8¼ x 5½ inches.

THE DYNAMICS OF CULTURE CHANGE: An Inquiry into Race Relations in Africa. By BRONISLAW MALINOWSKI. Edited by Phyllis M. Kaberry. xiv and 171 pp.; bibliogr., index. Yale University Press, New Haven; Oxford University Press, London, 1945. $2.50. 9½ x 6¼ inches.

The late Professor Malinowski made a very great contribution to the development of social anthropology. His work in the Trobriand Islands, though carried on thirty years ago, remains one of the best pieces of field research yet carried out. In his own reports on this area, and in his expositions on methods of field research (in "Argonauts of the Western Pacific" and in "Baloma: The Spirits of the Dead in the Trobriand Islands," *Journ. Royal Anthropol. Inst.*, 1916), he offers stimulating models for this type of work. He attracted to the London School of Economics and Political Science students from various disciplines, who applied his methods of research in Oceania and Africa; and indirectly he influenced every school of social anthropology in the world.

On the theoretical side, however, Malinowski's work does not stand up to criticism. His theoretical thesis may be considered in two parts. First, he starts from the obviously true statement that human beings in society are so conditioned by culture that it is impossible to distinguish their purely biological behavior. Through culture they satisfy certain basic biological needs, and the mechanisms by which they do this create derived needs that are again satisfied by culture. The "functions" of the institutions into which he divides culture are to satisfy these needs. This part of his thesis is in the field of psychophysiology rather than in that of sociology. Second, he argues that all human behavior is purposive, organized, and integrated. He analyzes this organization into institutions, which by his definition consist of a group of people associated for a definite purpose, using specific material apparatus under rules and norms, with a charter and tradition. These institutions are "integrals" that cannot be broken up. Good field research requires a detailed and comprehensive description of all the components of an institution as set out above.

This conception undoubtedly provides a magnificent framework for comprehensive field work and for the presentation of all the facts in a particular reality. Malinowski himself, though seemingly unaware of the full implications, admits it is "primarily descriptive." "The functionalist, to take a simple example, would insist that in describing a fork or a spoon we also must supply the information on how they are used, how they are related to table manners, to convivialism, to the nature of cooked viands and dishes." This is saying little more than that a man can begin by observing a stone, can describe its weight and color, go on to describe the soil it lies on, the plants that grow on the soil, the wind that blows through

their leaves, and so on. It is not a theory at all, but merely a technique for ensuring that the research worker acquires all the data in a particular field of reality. Nevertheless, it is the basis for a great advance in field work, as is shown in the progress of reports over the last two decades.

The strength of the concept of "integral institutions" contains an inherent weakness. Since the "institutions" are "integrals," they cannot be broken up, and analysis must dissect if it is to advance by comparing isolated events or aspects of events.

"Our meddling intellect
Misshapes the beauteous forms of things:—
We murder to dissect."

Malinowski, by denying that we have the right to dissect the form of reality, precludes analytical progress. On his thesis, a whale and a sheep are in reality too different to be classified together even though they have significant common characteristics.

In the earlier of the volumes reviewed here I find that this weakness shows in certain significant facts. The book is a posthumous publication consisting of three essays written at different times—The Functional Theory (1939), A Scientific Theory of Culture (1941), and Sir James George Frazer: A Biographical Appreciation (1942)—but I infer from the Preface that Malinowski himself made the initial preparations for publishing them together. They amount, including the essay on Frazer, to repetitive and polemical statement of the same thesis. Moreover, so far as they show any development from his article on "Culture" in the Encyclopaedia of the Social Sciences (1931), it is on the psychophysiological side, not on the cultural. Finally, in the essay on "A Scientific Theory of Culture" he says that functionalism lays stress "on the absolute necessity for an additional type of research. This consists primarily in a consideration of how certain devices, forms of organization, customs, or ideas enlarge the range of human potentialities on the one hand, and impose certain restrictions on human behaviour on the other. In short, functionalism is the consideration of what culture is as a determining principle, in terms of the addition which it provides to the individual and collective standard of living."

A scientific theory is valuable not only in solving problems but in posing new ones. Therefore, if Malinowski's theory were sound, we should find that in these three essays and in Part I of his later book, which covers much the same ground, he would concern himself with comparative problems requiring further research for new data or forming new patterns out of old data. As on the one hand he is locked in the "integrality of his institutions" and on the other hand he knows in advance what basic and derived needs the institutions satisfy for all societies, he is unable to do this. Therefore we find first that he restates the same thesis again and again, for he cannot develop it. Since he is unable to pose more advanced problems on the cultural plane, he retreats to a summary of behavioristic researches on the process by which human beings are conditioned by culture in the satisfaction of their needs. Finally, he attempts to escape from his impasse by giving as the comparative problem the relative extent to which culture contributes to the individual and collective standards of living (see quotation above). This is a general indication of what constantly emerges in detail—his tendency to start to pose an analytical problem, only to slip, almost unconsciously, into consideration of a practical problem. Even his essay on Frazer concludes with a naïve set of proposals for getting rid of war. This tendency dominates his more recent book, in Part II of which he discusses a number of African problems—"African Warfare," "Reflections on

Witchcraft," "Problems of Native Diet in Their Economic Setting," "African Land Problems," "Indirect Rule and Its Scientific Planning" (see detailed review in *Africa,* Vol. 17, 1947, pp. 103–121).

In this brief review I have not been able to do justice to Malinowski's very material contribution to social anthropology. Though I have criticized his writings severely, I have done so deeply conscious of his great achievements.—MAX GLUCKMAN

EUROPEAN POPULATION TRANSFERS, 1939–1945. By JOSEPH B. SCHECHTMAN. xi and 532 pp.; maps, bibliogr., index. (Studies of the Institute of World Affairs.) Oxford University Press, New York, 1946. $5.00. 8½ x 5½ inches.

From the vantage point of wartime employment as a specialist in population problems for the Office of Strategic Services in Washington, Mr. Schechtman, a Ukrainian by birth and early training, well versed in Slavic languages and in German, has produced a companion volume to Eugene M. Kulischer's "The Displacement of Population in Europe" (International Labour Office, 1943; reviewed in the *Geogr. Rev.,* Vol. 34, 1944, pp. 502–504). The bulk of the material presented in his book was pieced together from fragmentary newspaper reports, primarily of German, and secondarily of other ex-enemy, origin, an operation no doubt rendered possible by the spadework of OSS personnel. The results are an illuminating array of statistical data, descriptions, and dates detailing the transfer of German minorities from Estonia, Latvia, Lithuania, Rumania, Bulgaria, parts of the Soviet Union, Yugoslavia, and Italy to areas of resettlement in Nazi Germany and parts of Poland, Austria, and Yugoslavia incorporated into the Reich by Hitler. In addition, data are given on the transfer of non-German minorities within the Soviet Union and Finland and exchanges involving minority groups living in Bulgaria, Rumania, Greece, Hungary, and Yugoslavia.

Many years will elapse before the population movements depicted here can be even partly evaluated by demographic calculation and census analysis. The record has been disturbed, erased, and broken by war and concentration-camp casualties, by the two-way movement of millions of displaced persons from Eastern and Southern Europe, by the loss of life through famine, and now by the return to Rump Germany of 10 to 15 million Germans and *Volksdeutsche.* There is not enough evidence at hand even to begin to evaluate the accuracy of Mr. Schechtman's conclusions. One can only be grateful for this record of wartime research.—MALCOLM J. PROUDFOOT

THE POPULATION OF PHILADELPHIA & ENVIRONS AND LABOR FORCE & EMPLOYMENT ESTIMATES: A Projection for 1950. A Report to the Philadelphia City Planning Commission from the Population and Economic Research Advisory Committee under the Auspices of the Institute of Local and State Government, University of Pennsylvania, 1946. [Section 1,] iii and 43 pp.; [Section 2,] iii and 42 pp.; diagrs. 10¾ x 8½ inches.

This report, a twofold projection to the year 1950 for Philadelphia County and seven adjacent counties of Pennsylvania and New Jersey, provides a case study in the maze of considerations involved in demographic and economic extrapolation. In summary, the projections are concerned with questions of birth and life expectancy, of sex and age ratios, of emigration and immigration, of differentials in economic opportunity, of housing avail-

able and projected, and of trends in the habits of labor seeking, and management offering, employment. For some there is a stern warning here against hasty prognostications; for others, the question "Why calculate to the third decimal point if the basic assumptions are open to question?" In this case, the calculations were made under expert direction. One should be able to use the results with more than ordinary confidence, but necessarily with nothing like the assurance of results based on a census or even a sample census having 2 to 5 per cent coverage.

The conclusions of this twofold report are straightforward. Total-population census returns in 1940 (labor force in parentheses) are: (1) Philadelphia, 1,931,300 (884,000); (2) Environs, 1,268,300 (535,000); and (3) Philadelphia and Environs, 3,199,600 (1,419,000). Total population projected to 1950: (1) 2,023,300 (930,000); (2) 1,421,700 (620,000); and (3) 3,445,000 (1,550,000). Increases: (1) 92,000 (46,000); (2) 153,400 (85,000); and (3) 245,400 (131,000). In addition to these summary conclusions, there are many subordinate conclusions and refinements. The entire report is of such a concentrated factual nature that it is almost impossible to summarize it briefly. However, the many conclusions may well have an important bearing on the careful planning of future services and improvements for the City of Philadelphia, for attracting new industries to the city or its environs, and for integrating the plans of the city with those of its suburban satellites. There may be ample assurance that the refined conclusions of this report will be used by the Philadelphia City Planning Commission, but somewhat less assurance that its findings will be used by the duly elected representatives of the city's people or the practical local businessmen.—MALCOLM J. PROUDFOOT

THE COMPACT OF 1785. By CARL N. EVERSTINE. v and 34 pp. *Research Rept. No. 26,* Submitted September, 1946. Research Division, Legislative Council of Maryland, Baltimore. 11¼ x 8¾ inches.

To the reader familiar with the perennial oyster problems of the Chesapeake Bay area and the legal, political, and psychological scenery surrounding these problems, the present study will have more than academic interest. This compact, antedating the Federal Constitution of the United States, "has regulated some of the dual interests of Maryland and Virginia for more than one hundred and sixty years." Neither the shellfish nor the man gathering it has the respect for that legal convention the political boundary line which the lawyer and the statesman have; and this first comprehensive analysis of the application and administration of concurrent legislation by the two states makes fascinating reading.

The Compact still controls the fishing rights of citizens of both states, but its once even wider applications have long since atrophied. Many of its original provisions, centering around freedom of navigation, commerce, the imposition of tolls, and enforcement jurisdiction, gave way to controls imposed on the states by the Federal Constitution of 1787.

Everstine reviews the legislative and judicial history of the Compact and legal opinions relating to it given by the attorneys general of the two states. The study is invaluable as a case history of the application—or perhaps even of the inapplicability—of concurrent legislation when no provision for recurring review and adjustment is afforded. The only remaining practical proviso of the Compact, and this one giving rise to much of the interstate bitterness of today, is one that at the time was purely incidental to its main purpose. As has been indicated, this was the provision for equal rights of fisheries in the Potomac.

Even this incidental feature has not been blessed with too successful a career over the 160 years of its life, because of confusions still persisting as to the actual policing terms agreed upon. The whole record is eminently unsatisfactory, culminating in the distressing thought that perhaps the Compact cannot even be changed or repealed. "Some hold that when a compact is approved by Congress (as required by the Constitution) it thereupon becomes a Federal law and cannot be changed by one of the states alone. Others consider the compact as a contract, the obligation of which a State is constitutionally forbidden to impair."

The histories of other long-term compacts should be carefully analyzed by competent students. These case histories might then provide some clue as to how to convert a static document that is doing little more than stultify its original purposes into a dynamic instrument for concurrent administrative action by the states concerned.—ABEL WOLMAN

THE UNITED STATES AND THE NEAR EAST. By E. A. SPEISER. xvi and 263 pp.; maps, bibliogr., index. (The American Foreign Policy Library.) Harvard University Press, Cambridge, Mass., 1947. $2.50. 7¾ x 5¼ inches.

PALESTINE: A STUDY OF JEWISH, ARAB, AND BRITISH POLICIES. Vol. 1, xxii and 593 pp.; Vol. 2, ix and 595–1380 pp.; maps, diagr., bibliogr., index; with accompanying 3-sheet map in separate folder. Published for the Esco Foundation for Palestine, Inc. Yale University Press, New Haven; Oxford University Press, London, 1947. $12.00. 9½ x 6¼ inches.

Professor Speiser's book is an invitation to Americans to abandon the habitual attitude of "dutiful negligence" toward the lands about the eastern end of the Mediterranean and to seek to understand their problems and the problems they pose for the rest of the world. These lands, anciently of interest as the font and origin of our civilization, now claim our urgent attention; for here, today, "you find concentrated the full complement of geostrategic requirements: central strategic location; convergence of land, water, and air routes; and vital natural resources." From a lifelong study of the ancient Near East, with a wartime focus on modern conditions, the professor of Semitics at the University of Pennsylvania is eminently qualified to discuss the problems of the region; he does so with remarkable success because he writes with wit as well as with wisdom. If the region he deals with is, "in countless subtle ways, the product of its ageless past," he subtly conveys the manifold implications by his choice of word and phrase—and in a scant 250 short pages.

The Near East of Professor Speiser's definition—he explains his preference for "Near" over "Middle"—comprises the individual areas of Egypt, Syria-Palestine, Mesopotamia, and the Arabian Peninsula, and constitutes a natural unit, with unity largely conferred by a "way of life." But within the region individual areas show strong differences, as they have done since the beginning of recorded time. The recent vying of Egypt and Iraq for leadership of the Arab unity movements may be matched against the conflict between the Egyptian Necho and the Babylonian Nebuchadnezzar. The traditional hostility of the ruling family of Egypt and the House of Saud still remains unresolved. The violent state nationalism of Egypt is a different thing from the religious nationalism of Saudi Arabia; and although the sectarian theocracy of the Yemen is no less fanatic than the latter, the two Arabian countries are "poles apart from each other in the particular orientation of their respective religious doctrines." French culture is still admired in the Levant states; Transjordan boasts a "brand-new constitutional monarchy"; Iraq in certain respects turns to the Indian Ocean and Moslem

India. The Arab League itself has been erected mainly on a negative foundation. Differences within the Semitic world come to a head in Palestine.

The Palestinian problem is in part an economic and social problem, a matter of standard of living, as was emphasized by the Anglo-American Committee of Inquiry. Economic expansion is tied with immigration. Professor Speiser deals lightly with both points, but here again one may refer to the cautious words of the Committee's report on, for example, agricultural and industrial development plans: "Their full success requires the willing cooperation of adjacent Arab states, since they are not merely Palestinian projects."

But this is not all. "To appreciate . . . the Palestine issue in all its complexity, one must view it not only as the indigenous problem of a very small country; one must regard it also as a grave regional issue, a British Empire problem, and a world problem." Here, besides the question of Arab and Jew, is that of the third party, the ruling power, another ancient problem for the "Ordained Land." "Throughout her long history there have been few intervals during which Palestine was permitted to order her own affairs. Authority over the country has resided—with the exception of a few centuries in the Davidic era and thereafter—in some center extraneous to it, one, moreover, which controlled larger regional or inter-regional interests: Egypt, Mesopotamia, Persia, or Syria; Rome; successive capitals of the Arab Empire; Turkey; and, lastly, Britain." When the issues are boiled down to their simplest terms, the Arab case rests on the fact that "they have a majority in the country which is unalterably opposed to Zionist political aims"—Professor Speiser reminds us that the word "zealot," which accurately describes the Arab attitude, acquired its specific connotation in Roman-ruled Palestine. The "spiritual and psychological content of Zionism . . . is the essence of the Jewish case, . . . overwhelmingly a human problem." On the British case, which is examined very realistically, Professor Speiser quotes Bevin: Palestine is "the throat of the British Empire." Within each of the three principal parties differences exist—extremists in the Arab and Jewish ranks; even in British officialdom differences between the Foreign, Colonial, and India Offices. And yet, beyond the manifold differences that "keep the modern Arab world in a state of perpetual agitation," there remains the inescapable fact of a single, closely-knit culture occupying a pivotal world area. Such an act as the recent exploit of Abd el Krim reminds us that "the voice of the Arabs reverberates in Bengal and Malaya, and in North Africa and the Dardanelles, not to mention the Russian sections of the Islamic community."

The concluding chapter deals specifically with the United States, now drawn into the Near East by strategic and economic interests. Professor Speiser urges the formulation of a policy regional, realistic, and independent. He re-emphasizes the cultural and psychological unity of the region as a whole: "To deal with one local state is to invite the intimate participation of the rest." The very magnitude of the oil interests of Arabia, for instance, makes a "balanced regional economy all the more difficult of attainment." He warns against the gulf that still exists between East and West, the medieval social structure and the superficiality of the modern veneer over these ancient lands. The state of health and education is remote from Western standards; for example, "except for a single theological college, Saudi Arabia has no real institution of higher learning." However, according to recent reports the Near East College Association is studying the educational problem at the request of King Ibn Saud and the Arabian American Oil Company at Dhahran.

In stressing independence of policy, Professor Speiser is thinking expressly of an Anglo-

American bloc, but he adds: "It should be stressed repeatedly, in view of various rece. developments, that an independent American policy in the Near East would not necessari be a pro-Russian policy merely because it has ceased to be a British-sponsored or Briti. approved policy." Events move rapidly; the political picture changes; if British strategy swings southward from the Mediterranean (compare the abstract of Hans W. W's paper "New Strategic Frontiers in the British Empire," *Annals Assn. of Amer. Geog.*, Vol. 37, 1947, pp. 58–59), then the United States will face Russia in the Near East.

According to Professor Speiser (*New York Herald Tribune Weekly Book Review*, May 25, 1947), the two-volume work on Palestine published for the Esco Foundation "addresse itself with candor and earnestness to a presentation of Jewish, Arab and British policies on the subject. The approach is frankly sympathetic to Zionism, but the study is by no means unduly partisan." The work is cooperative, factual, and comprehensive. After an introductory chapter on the growth of Zionism in the nineteenth century, it deals with events and policies in Palestine from the Balfour Declaration to the Report of the Anglo-American Committee of Inquiry. There are an extensive bibliography and a full index, and geographers will note with approval the inclusion of the three-sheet map of the Survey of Palestine on the scale of 1 : 250,000, with a supplemental list of Jewish settlements too recent to be shown on the map.

THE PROBLEM OF THE TURKISH STRAITS. [By HARRY N. HOWARD.] iv and 68 pp.; map. *U. S. Dept. of State Publ. 2752 (Near Eastern Ser. 5)*, 1947. 30 cents. 10¼ x 8 inches.

This publication presents in compact form the diplomatic background of the current difference of opinion regarding the future regime of the Turkish Straits. It includes an analysis of the Montreux Convention, selections from, and a comparative tabulation of, this and other conventions, and a brief outline of "the great debate" of 1945–1946, followed by texts of notes exchanged in the course of this "debate." There is, naturally, no exposition of the larger problem of Soviet-American relationships and no attempt to evaluate the strategic or other stakes of the great powers in the region.

A comparison of the American and Soviet proposals made since the end of the war shows considerable agreement but also a fundamental disagreement. Both powers agree that the Straits should always be open to merchant ships of all countries and to warships of the Black Sea states. They also agree that the Straits should be closed to other warships, with limited exceptions. The disagreement relates to defense. The United States has proposed, and the British and Turkish governments concur in general, that defense should be Turkish, with action by the United Nations Security Council possible in case of attack or threat of attack. The Soviet government has suggested that "the establishment of a regime of the Straits . . . should come under the competence of Turkey and other Black Sea powers" and that Turkey and the Soviet Union should defend the Straits jointly. The nub of the argument appears in the Soviet note of September 24–25, 1946, and the Turkish reply of October 18, printed in the last part of this publication.—STEPHEN B. JONES

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THE ORINOCO-VENTUARI REGION, VENEZUELA

CHARLES B. HITCHCOCK

[With separate map, Pl. II*, facing p. 566]

"THE geographers of Europe are no doubt in the wrong not to embrace the way of thinking of the Indians, who are the geographers of their own country."[1] When Humboldt made this comment, he had in mind a vast, unexplored, unexploited region in equatorial Venezuela and adjoining Brazil—the territory of the upper Orinoco River, the Casiquiare Canal (the existence of which was still debated by certain Europeans), and Guainía River. Such a country, bounded west and south by the Orinoco and on the east by the Ventuari, still exists, keeping the details of its locational geography for its own geographers. But even a slight acquaintance with some of the "uncivilized" inhabitants will soon convince one of their keen understanding of their country and its resources. The outside world has penetrated in search of marketable products only along the routes of least resistance. If it were not for the airplane, the camera, and the outboard motor, it would still be impossible to prepare even a summary description of the region without months of difficult travel.

Purpose of the Expedition

The expedition that the writer had the pleasure of accompanying was planned and organized by Mr. William H. Phelps, Jr., primarily for the purpose of collecting the subtropical and tropical avifauna of the Río Ventuari region. Residents on the lower Ventuari had told of higher country upstream. Elsewhere in the Venezuelan Guayana isolated mountains rising

*Grateful acknowledgement is due to Mr. William Briesemeister for assistance in the construction of maps of the Río Ventuari and of the Río Manapiare basins and to Mr. E. D. Weldon for preparation of the finished drawings.

[1] Alexander de Humboldt: Personal Narrative of Travels to the Equinoctial Regions of the New Continent, during the years 1799–1804, by Alexander de Humboldt and Aimé Bonpland, written in French by Alexander de Humboldt, and translated into English by Helen Maria Williams, 7 vols. (in 8), London, 1818–1829; reference in Vol. 5, Part 1, p. 222.

into subtropical altitudes and surrounded by tropical lowland are known to support an extraordinary series of life forms, evolved, at least in part, into a specialized endemic flora and fauna.[2] Mt. Roraima is perhaps the best known of these mountains, and collections were obtained from it as far back as 1842. Birds have since been collected from similar subtropical mountains to the west—Auyan-tepui, Ptari-tepui, Chimantá-tepui, Guaiquinima, Duida, and Sipapo (or Paraque). Except for Roraima and Duida, the collections are the result of the efforts of Mr. Phelps and his father. It was hoped that the mountains reported in the upper Ventuari region would furnish an intermediate station to assist in solving the problem of bird evolution and distribution in the broad Venezuelan Guayana.

A study of air photographs revealed a promising area, not in the region originally suggested, but in a group of dissected table mountains about the headwaters of the Río Manapiare, a right-bank tributary of the Ventuari about which no detailed information was available.

The two early chroniclers of the Orinoco region, the Jesuit priests Gumilla and Caulin, make no mention of these mountains in their records. The Italian missionary Gili was the first to call them to attention.[3] Indians had described to him high, cold country in the headwaters area of the Manapiare, and although he never visited the region, he referred briefly to Cerro Yaví, or Javi, as he called it. Humboldt knew of Father Gili's report, but he did not ascend the Ventuari. For a century the region went unnoticed. Then, in 1913, Koch-Grünberg, the German anthropologist, traveling westward from Roraima down the Ventuari, referred briefly to high country in the headwaters area of the Manapiare and described in some detail an isolated mountain, Cerro Camani or Anaitya. This mountain, the southernmost in the area, is conspicuously visible from the Ventuari.[4]

Before the expedition entered the region on the ground, an air traverse between the Orinoco and the Ventuari was made in a plane of the Venezuelan air mission under the command of Colonel Douglas Williams. Mr.

[2] F. M. Chapman: Problems of the Roraima-Duida Region as Presented by the Bird Life, *Geogr. Rev.*, Vol. 21, 1931, pp. 363–372. Other articles in the *Geographical Review* discussing specific mountains of the Guayana highlands are: G. H. H. Tate and C. B. Hitchcock: The Cerro Duida Region of Venezuela, Vol. 20, 1930, pp. 31–52; G. H. H. Tate: Notes on the Mount Roraima Region, *ibid.*, pp. 53–68; *idem:* Auyantepui: Notes on the Phelps Venezuelan Expedition, Vol. 28, 1938, pp. 452–474; Bassett Maguire: Notes on the Geology and Geography of Tafelberg, Suriname, Vol. 35, 1945, pp. 563–579.

[3] Filippo Salvadore Gili: Saggio di storia americana o sia storia naturale, civile, esacra de regni e delle provincie spagniola di terraferma nell' America Meridionale, 4 vols., Rome, 1780–1784.

[4] Theodor Koch-Grünberg: Vom Roroima zum Orinoco: Reisen in Nordbrasilien und Venezuela in den Jahren 1911–1913, *Mitt. Geogr. Gesell. in München*, Vol. 12, 1917, pp. 1–79. See sketch of the mountain on p. 35.

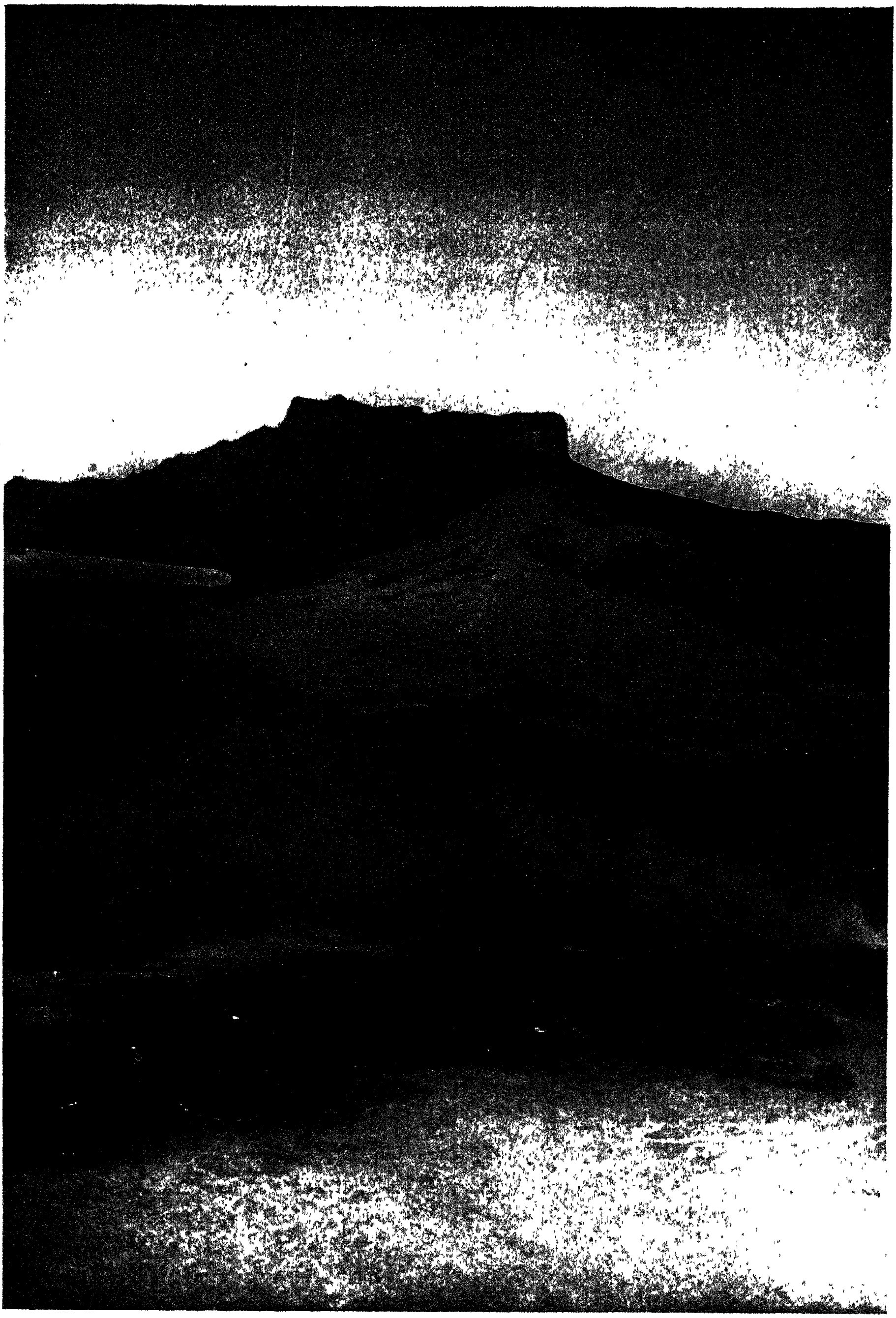

FIG. 1—Cerro Yaví (7600 feet), looking northwest. Savanna and gallery forest of Caño Parucito in the foreground. Savanna and bracken growth extend up the eastern ridges. The more gentle lower slopes are developed on granite and diorite; the summit area is of interbedded sandstones and conglomerates. (Photograph by G. Zuloaga.)

and Mrs. Phelps and the writer were then landed at the air strip at Puerto Ayacucho, and, with two bird collectors, the party proceeded by way of the truck road around the great rapids of the Orinoco 40 miles south to Sanariapo, at the end of the road. From this point travel was largely by boat—by launch as far as San Juan on the Río Manapiare; then up the Caño Parucito by motor-powered *falca* (a large dugout canoe with ribs and lapstreaked planks added to increase capacity) and canoe to a point within four days of the head of navigation and within 10½ miles of the cliffs of Cerro Yaví. Sanariapo was left on February 4, 1947, and the final river destination was reached on February 16—a total travel time of 101 hours. The return trip required 72 travel hours to cover the same route and bring us back to Puerto Ayacucho on March 13.

The Country Traversed

In the vicinity of Puerto Ayacucho the landscape is characterized by broad grasslands underlain by alluvium, above which isolated, rounded hills of bare granite rise abruptly. Many of the smaller granite outcrops carry pronounced vertical flutings (Fig. 13), which may very likely have resulted from solution. To the eye, the rock appears to be a uniformly coarse crystalline, with no apparent textural reason for the selection of solution channels. A few of the rocks have fractured and split apart, and in these the fractures coincide with the troughs of the flutings, suggesting differential erosion on a minute jointing system.

Near the Orinoco the small streams have been rejuvenated and are entrenched beneath the surface of the plain. Many of the granitic hills show evidence of former water action in the presence of large potholes more than 100 feet above the present river level—a feature noted by Humboldt in his journal. Fifteen miles to the east a series of hills with generally accordant summit levels rise from the lowland. On our eastward flight from Puerto Ayacucho we found these hills to be the western limit of a maturely and intricately dissected upland with an average elevation estimated at 3000 to 3500 feet and with streams characterized by numerous rapids and falls.

Eastward, the upland gains somewhat in elevation; the relative relief increases, and the texture becomes coarser. At about 66° 30′ W. the upland gives way suddenly to a series of cliffed sandstone tablelands, in places more than 7000 feet high, separated by broad valleys with meandering streams. This is the area later visited on the ground. The cliff-making sandstone is not horizontal but undulates in broad flexures, rising where the mountains

are higher. The appearance is that of a region subjected to broad, gentle doming.

At the extreme western limit of the dissected upland, 75 miles to the west-southwest, an isolated sandstone mountain, Cerro Sipapo (Paraque), rises above the average level to nearly 5500 feet. In other parts of the upland the topographic expression suggests other outliers of sedimentary rock; for instance, Serranías Guayapo and Guapuchí, seen from the Orinoco, and Serranía Parú, a range of cliffed mountains 35 miles east of the Ventuari, which is almost certainly high enough to support a subtropical flora and fauna. The presence of nearly horizontal sandstone overlying the basement complex in widely separated areas indicates that at one time the entire upland area was overlain by sandstone. The accordance of summit levels may thus reflect, at least in part, the former surface on which the sediments were laid down, stripped, and dissected.

The systematic arrangement of the major drainage suggests structural control, the streams following joints, fault lines, or the strike of the rocks. In the northern upland a striking feature is the parallelism of drainage courses in a rectangular pattern.[5] To the south, the combined Ventuari-Orinoco from the Río Marueta westward to San Fernando de Atabapo swings in a broad arc, paralleled by the Guayapo, the upper Sipapo, and, to a smaller extent, the Autana. The general southwesterly trend of the Caño Parucito follows the strike of the rocks, though the stream meanders freely above a local base level.

In marked contrast with the great grass-covered llanos of Colombia, which extend westward from the Orinoco to the foothills of the Andes broken only by gallery woods and swamp vegetation along existing or abandoned drainage channels, the region between the Orinoco and the Ventuari is for the most part covered with deciduous tropical forest. Along the right bank of the Orinoco, however, there are marginal patches of savanna with scattered chaparro trees, and locally the mountains have sufficient altitude to support subtropical growth.

East of the Ventuari and north of the Río Marueta the lowland is largely forest-covered. It is not until one reaches the Río Manapiare that extensive grasslands are found. The existence of these savannas has long been known —Father Caulin had heard of them; Father Gili mentioned them in 1780, and Humboldt later referred to Gili's comments—but their extent had

[5] Fault control as a major influence on the pattern of the Orinoco and the Casiquiare has been suggested in "Report on the Orinoco-Casiquiare-Negro Waterway, Venezuela, Colombia, Brazil, July, 1943," prepared by South Atlantic Division, Corps of Engineers, U. S. Army, Atlanta, Ga., Vol. 1, p. 21.

FIG. 2—Maturely dissected and heavily forested upland, looking north from 5° 08′ N., 67° 16′ W.; altitude of plane 20,000 feet. The stream in the middle distance is the Río Cuao. (Courtesy of the Venezuelan Government.)

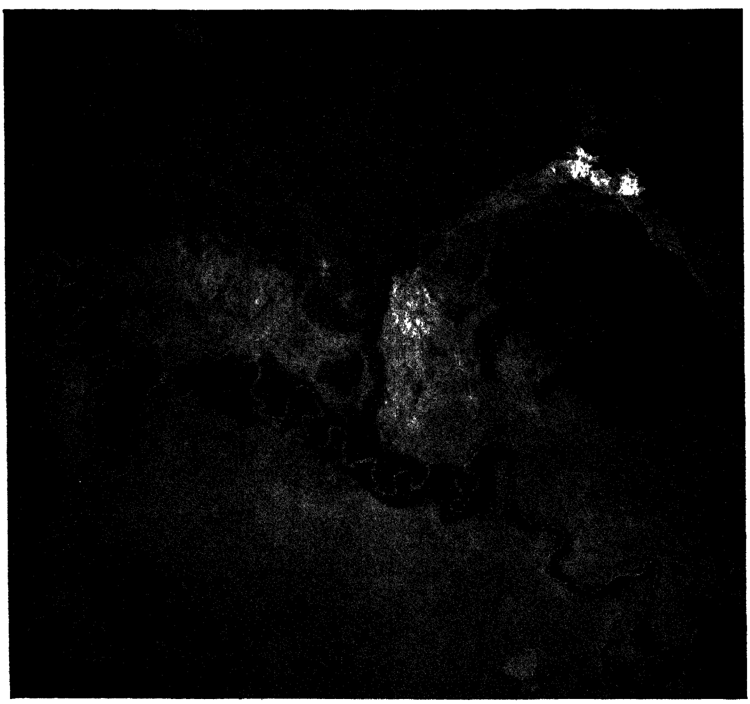

FIG. 3—Gallery forest of Caño Parucito. The center of the picture 5° 20′ N., 65° 57′ W.; altitude of plane 20,000 feet. Direction of stream flow is to right, or southwest. Note savanna reaching to river bank in many places. (Courtesy of the Venezuelan Government.)

FIG. 4—Maturely dissected upland 23 miles east of Figure 2. Note greater relative relief, straight course of valley on right, rectangular pattern of tributary valleys. Cerro Guanay(?) in upper right corner; hills in the left foreground part of Serranía del Cuao. (Courtesy of the Venezuelan Government.)

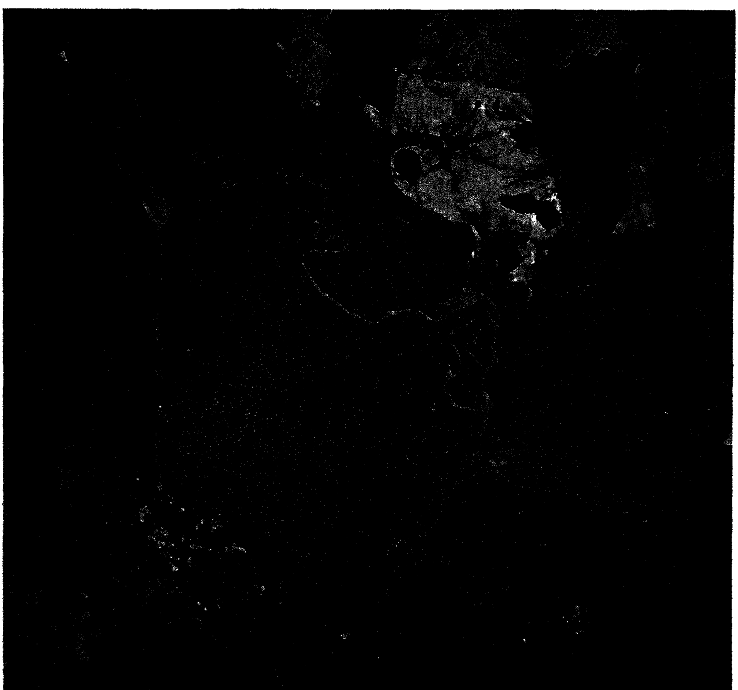

FIG. 5—To left, Río Ventuari at mouth; to right, Orinoco and part of Raudales de Santa Bárbara: altitude of plane 20,000 feet. Direction of flow toward bottom of picture. Small meandering stream is Caño Desecho. (Courtesy of the Venezuelan Government.)

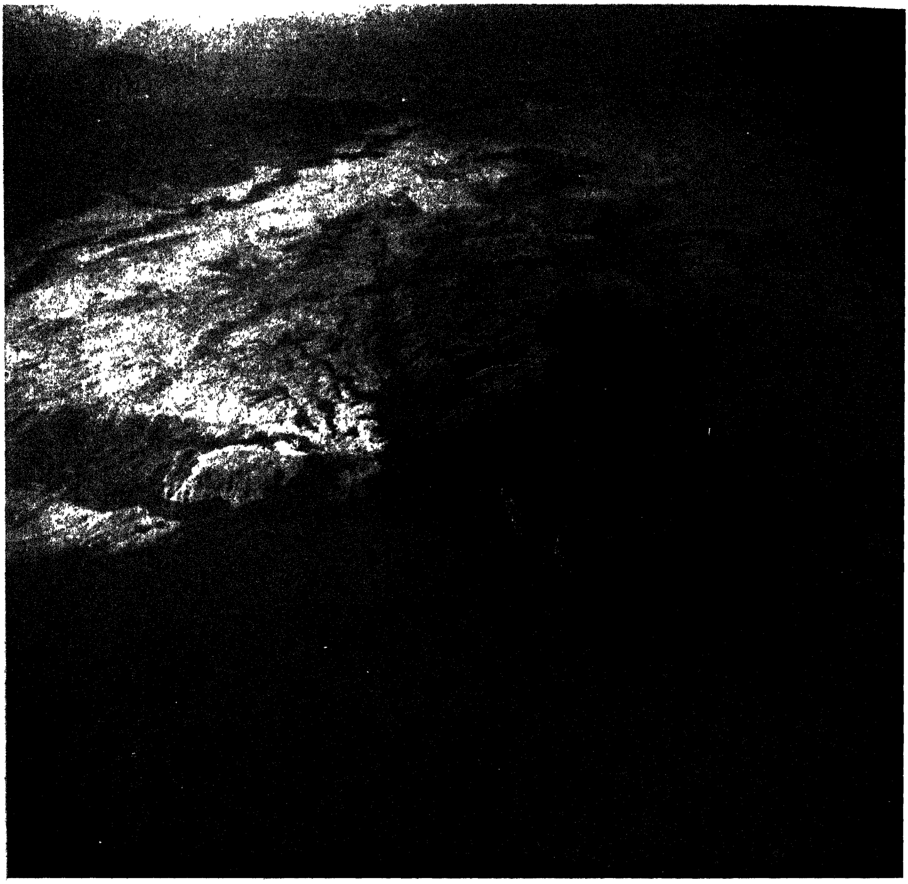

FIG. 6—In right foreground, Cerro Yaví, with summit area cut by large valley at head of Caño Platanal. South from 5° 34′ N., 65° 59′ W.; altitude of plane 20,000 feet. North and west slopes heavily wooded; grasslands rising on eastern and southern ridges from savanna lowland of Caño Parucito. (Courtesy of the Venezuelan Government.)

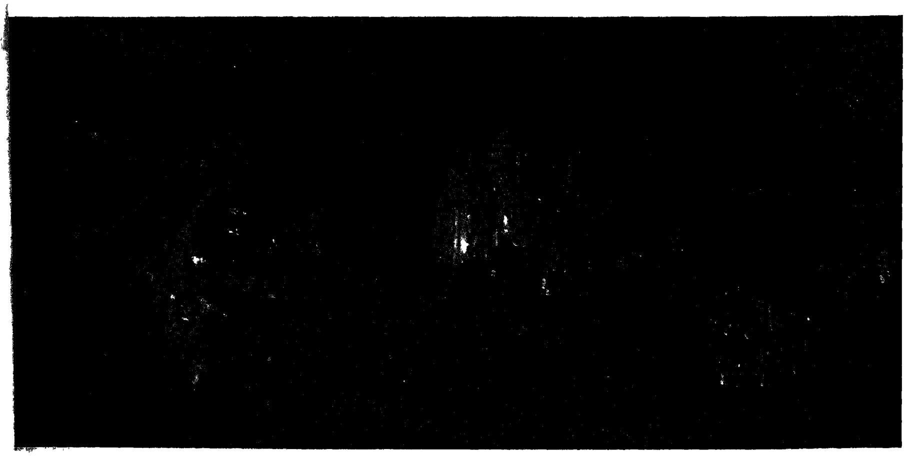

FIG. 7—Sugar-loaf hills of bare rock, characteristic of granitic weathering, rising from dense forest. Landscape is typical of the country east of Puerto Ayacucho. (Photograph by G. Zuloaga.)

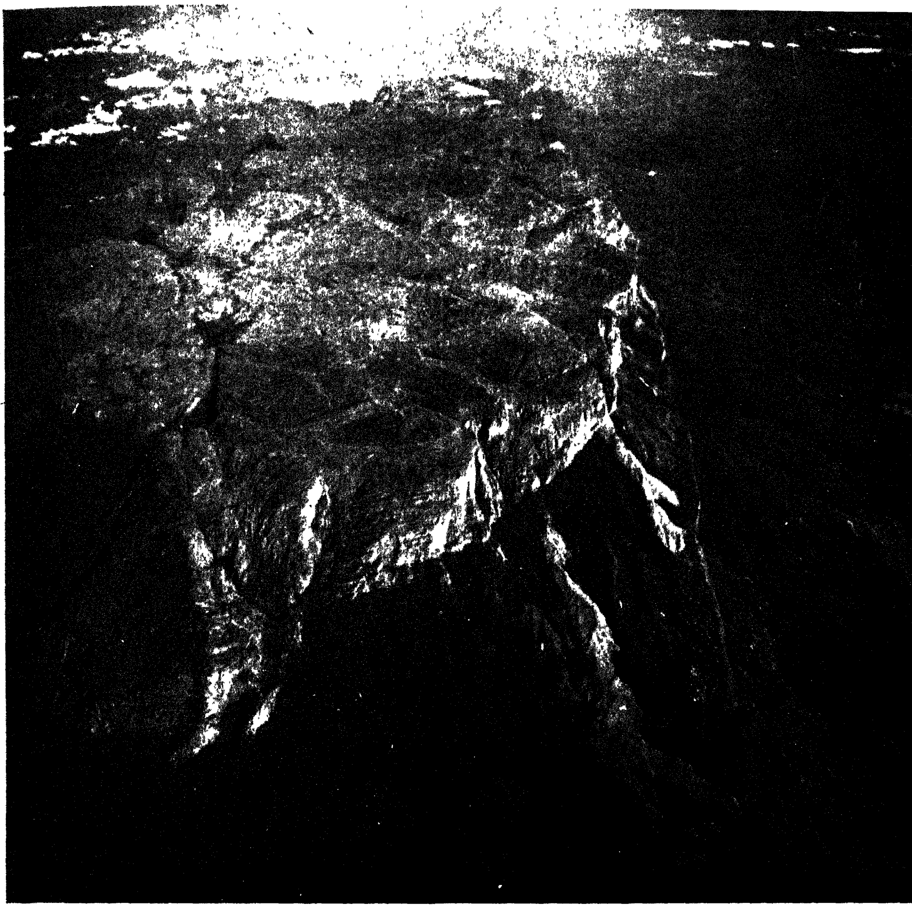

FIG. 8—Unexplored table mountain, Cerro Guanay (?) approximately 7600 feet, in the headwaters of Caño Guaviarito (cf. Fig. 4). North from 5° 34′ N., 66° 27′ W.; altitude of plane 20,000 feet. Note the unforested ridges in foreground. (Courtesy of the Venezuelan Government.)

FIG. 9—Boat of the Phelps Expedition, the white object at the stream bank of Caño Parucito in the center of photograph, as seen from the plane of Venezuelan air mission, March 7, 1947. (Photograph by G. Zuloaga.)

not been determined. Through aerial and ground reconnaissance it has been possible to show the approximate areas and distribution of these and other savannas on the map, Plate II.

The Orinoco from Sanariapo to Río Ventuari

Our course up the Orinoco and tributaries will be briefly described. The section of the Orinoco flowing almost due north from San Fernando de Atabapo to the head of the Maipures Rapids may be considered a distinct unit. The waters, brown with sediment, flowed between banks of yellowish alluvium some 15 to 20 feet high. Granitic outcrops were abundant and characteristic, appearing both as smooth rock ledges projecting from the riverbanks and islands and as isolated rocks. High-water marks were prominent everywhere in the rocky stretches, and particularly on the sides of Isla Castillito, which reminded Humboldt of the Mouse Tower of the Rhine.[6] There were occasional sandbanks, brownish in color. Dense, high tropical forest, with many vines and scattered palms, reached to the edge of the water, thinning where savanna approached the river. Few of the trees and vines were in flower, and some of the taller trees, spreading out above the general forest level, had shed all their leaves.

From Isla Ratón, Cerro Sipapo was conspicuous nearly 25 miles to the east. For a short time a small mountain, one of the Cerros Autana, could be seen to the south, rising abruptly from the lowland, and the Cerros del Mono, a group of wooded hills, paralleled the left bank of the river for a short distance. Otherwise the continuous high forest was relieved only by occasional low, rounded hills rising some 150 to 500 feet above the trees. Relatively few birds and mammals were seen, and in the first day's travel, only a few canoes and one motor-powered *falca*.

As San Fernando came in sight, there was a remarkable change in the scene. The waters of the Atabapo were inky black and flowed among extensive sandbanks of the purest white. Riverbank vegetation was considerably lower, and the foliage a lighter green.

Above the junction of the Orinoco with the Guaviare the main river flows almost due west for 45 miles. In contrast with the stretch north to the Maipures Rapids, rock outcrops were few, the alluvial banks were 30 feet high in some places, and large brownish sand bars were numerous as far east as 67° 25′ W. The main channel wanders from bank to bank in a series of great curves, which must be followed by all but the smallest canoes. The striking abundance of sand in this part of the river, "exorbitante copia

[6] Humboldt, *op. cit.*, Vol. 5, Part 2, p. 613.

de arenas," was commented on long ago by Father Caulin.[7] It may result from the entrance of the large, sediment-laden Ventuari only a few miles upstream.

From the sandy east-west stretch of the river a series of prominent peaks, cliffed and suggesting the presence of sedimentary rocks, could be seen to the north, trending approximately N 60° E. The southernmost was about 25 miles from the river. It was said that the best approach to these mountains, the Serranía Guayapo, would be by way of the Río Sipapo and its tributary, the Guayapo. For a while, the isolated, mesa-type mountain, Cerro Yapacana, near the right bank of the Orinoco above its junction with the Ventuari, was conspicuous, bearing S 60° E.

The Río Ventuari

The Ventuari enters the Orinoco in the Santa Bárbara Rapids by four mouths, separated by picturesque wooded islands (Fig. 11). About five miles above the junction a small stream, Caño Desecho, cuts off from the left bank of the Ventuari in the wet season and enters the Orinoco separately. During the dry season the Desecho is often separated from the Ventuari by a sandbank and carries only the waters of the Maraya, a little stream entering a short distance below the Ventuari outlet (Fig. 5). At the beginning of the wet season the upper Orinoco may be in flood while the Ventuari is still falling, and at such times the Desecho temporarily reverses its flow.

The lower course of the Ventuari is rocky, and in early February the channel in many places carried not more than two feet of water. Nowhere to the mouth of the Río Manapiare is the river free-meandering.

Savanna reaches the river only locally; elsewhere dense woods extend to the banks. From the lower river the Serranía Guapuchí (apparently the mountains referred to by Koch-Grünberg as Cerro Sipapo) was visible at intervals to the west; upstream, hills and low mountains became more numerous. A short distance below the mouth of the Río Marieta we had our first view of Cerro Yaví.

Petroglyphs on the Río Manapiare

Along the Manapiare occasional glimpses could be had of the mountains to the north, but in general the view was cut off by thick gallery forest, which gave little indication of the extensive savannas through which the stream flows. An interesting feature was a series of crude carvings on a

[7] Antonio Caulin: Historia coro-graphica natural y evangelica de la Nueva Andalucía provincias de Cumaná, Guayana y Vertientes del Río Orinoco, Madrid, 1779, p. 72.

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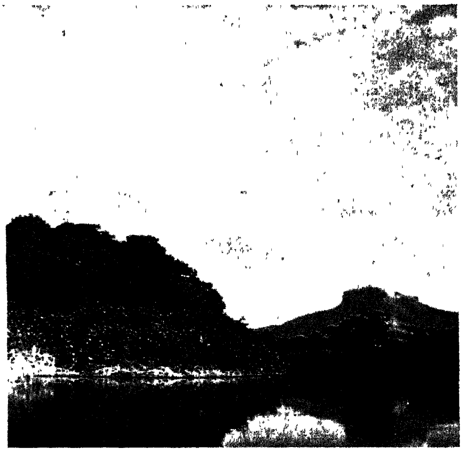

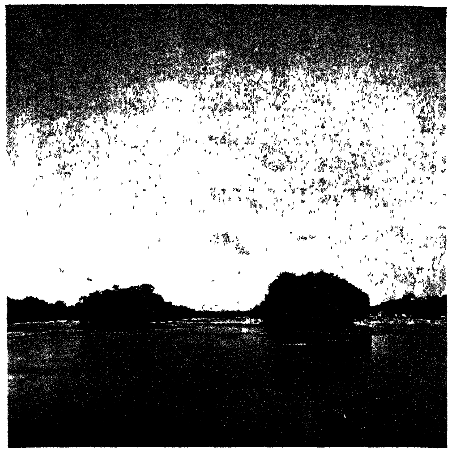

FIG. 10 (left)—The Caño Parucito. Cerro Yaví seen to the north. (Unless otherwise credited, photographs are by Mr. and Mrs. Phelps.)

FIG. 11 (right)—The mouths of Río Ventuari as seen from the Orinoco.

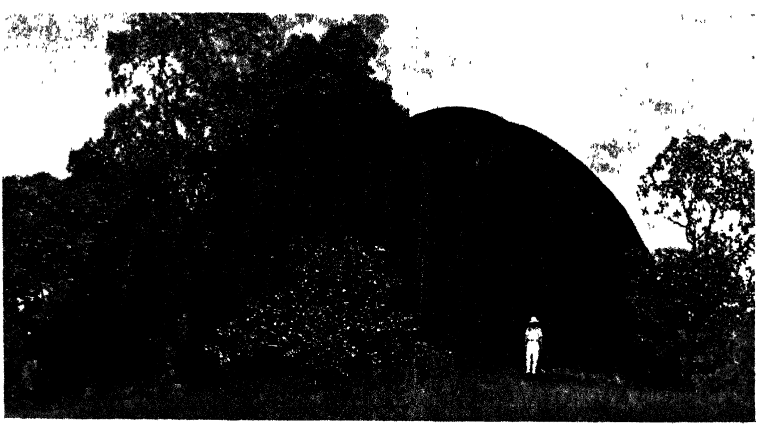

FIG. 12—Savanna country near Puerto Ayacucho, with coarse bunch grass and much bare ground.

FIG. 13—Coarsely crystalline granite outcrop with vertical fluting (see p. 528).

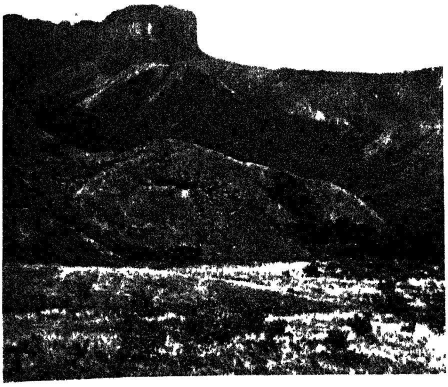

FIG. 14 (left)—Grass-covered lower slopes of Cerro Yaví; dark vegetation in right middle distance is a wild growth of plantains.
FIG. 15 (right)—Savannas of the Caño Parucito with chaparro trees. Looking north.

FIG. 16—A plant, probably *Barbacenia aleaxndrina* Schomburgk, but possibly a new species, characteristic of the thin, granitic soils of the savannas near Puerto Ayacucho. In the distance, the western front of the forested upland, with accordant summit level.

FIG. 17—The Río Manapiare, from the hill at San Juan. Smoke is from near-by Indian settlement.

heap of boulders on the left bank of the river 14½ miles above its junction with the Ventuari. These rocks, accumulated from the weathering of a diorite outcrop (geological sample no. 11), were decorated with likenesses of animals, a figure that possibly represented the sun, concentric circles and other geometric patterns, and a number of unrecognizable objects. The carvings were graven in hard rock to a depth of as much as 0.5 centimeter and must have been inscribed after the disintegration of the original outcrop, since many of them partly encircled the boulders. Some of the rocks must have been displaced since the inscriptions were made; for it would have been impossible to carve them in their present positions. Displacement may account for the presence of carved rocks even below the dry-season level of the river.

Crude petroglyphs have been noted in many parts of the South American tropical lowlands. Humboldt reported "mishapen figures, representing the heavenly bodies, and tigers, crocodiles, boas, and instruments used for the fabrication of the flour of cassava"[8] on the banks of the Casiquiare Canal. Rock carvings have also been described at various places on the Orinoco from the upper river nearly to the delta, and on the major tributary streams, including the Caura and the Cuchivero, which drain northward from the height of land marking the basin of the Río Ventuari.

Nothing definite is known about the civilization that left these records. Marcano[9] suggests that they might have been made by the people whose bones and simple burial urns have been found in caves near Puerto Ayacucho, but this can be considered only a speculation. No such practice is carried on by the indigenes of the present time, nor is it described in the records of the eighteenth-century missionaries in the Orinoco basin. The local inhabitants know of these carvings but attach no importance to them, calling them (as in the time of Humboldt) merely *piedras pintadas*.

Caño Parucito

On the lower Parucito it was necessary to disembark and haul the boats through three short rapids; a fourth stretch of swift water was navigated without difficulty. Above the rapids the stream meanders freely and is constantly shifting its channel, undercutting its alluvial banks, and felling great trees across its course. These fallen trees, and not the shallowness or swiftness of the water, are the principal navigational hazard. In one day more than 80 trees impeded progress, and a number of them had to be cut

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[8] Humboldt, *op. cit.*, Vol. 5, Part 2, p. 594.

[9] G. Marcano: Ethnographie précolombienne du Venezuela: Région des raudals de l'Orénoque, Paris, 1890, p. 117.

FIG. 18

FIG. 19

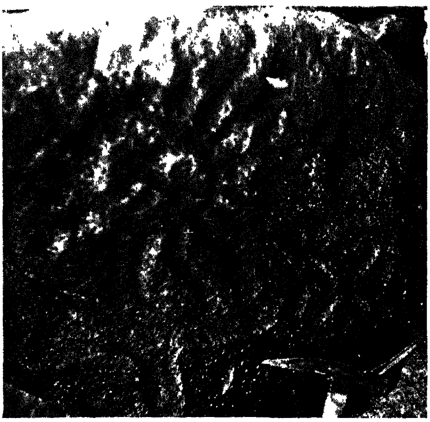

FIG. 20

FIG. 21

FIG. 22

FIG. 23

FIGS. 18–23—Petroglyphs of the Río Manapiare: 18, bird; 19, alligator or lizardlike figure, with head at top, four legs, and tail; 20, a sun (?); immediately above hammer, a perfect maltese cross which may postdate the other carvings; 21, concentric circles; 22, undecipherable markings; 23, general view of site, showing geometric pattern common to many of the carvings.

away with an ax; only five miles was covered that day. The Guaviarito, the other major tributary of the Manapiare, is said to present similar difficulties. Much debris was being carried by the waters. Sandbanks were composed of alternate layers of sand and leaves, and on many of them a brilliant green grass had sprung up, contrasting markedly with the yellow sand bars of the Orinoco and the white sands of the Atabapo.

Fish and wildlife had been abundant along the Ventuari and the Manapiare and proved to be even more so on the Parucito. There was never any question about obtaining enough fish. Nearly every sandbank yielded an ample supply of turtle (terecay) eggs. Tapir, wild pig, capybara, monkeys of several kinds—in fact, most of the larger mammals of the South American tropics—were seen at one time or another. Usually they showed little fear of man. Porpoises were seen almost to the farthest point reached on the Parucito, and large numbers of Muscovy ducks on the lower part of the stream; it was not uncommon to see 75 or 100 ducks in a single flock.

Not until we had reached the Parucito did savannas become extensive. In many places the only evidence of former gallery forest was a solitary tall tree near the riverbank, branching out 40 to 50 feet above the base. Charred trunks of trees were common in such areas, indicative of the fires that, we had been told, are set annually in the grasslands. Where the meanders were broad and widely spaced, savanna often reached the river, particularly along the undercut bank. Forest vegetation could not withstand the combined attack of fire and water.

Fire as a Savanna-Making Agent

At the time of our visit the savannas were extremely dry, and it was no surprise to see smoke far to the north of the Parucito even before we reached our final stop near Cerro Yaví. Within the next few days tremendous fires had advanced southward, crossed the river, and were burning to the north and east of the base camp, climbing the low ridges and spreading high up the eastern slopes of Yaví. Only upon reaching the gallery woods along the river did the fires die out. Trunks of the chaparro and palm trees near the base camp were charred from previous fires.

A small, rocky savanna at 2475 feet had been burned over shortly before we crossed it; on our return, 11 days later, we found there a small sedge in bloom, sparse bunch grass had pushed up several inches above the ground, and ants had remade their roads. A marginal belt of trees some 15 to 20 feet wide had been damaged considerably by fire; the picture was that of a grassland gradually expanding at the expense of the surrounding forest. At

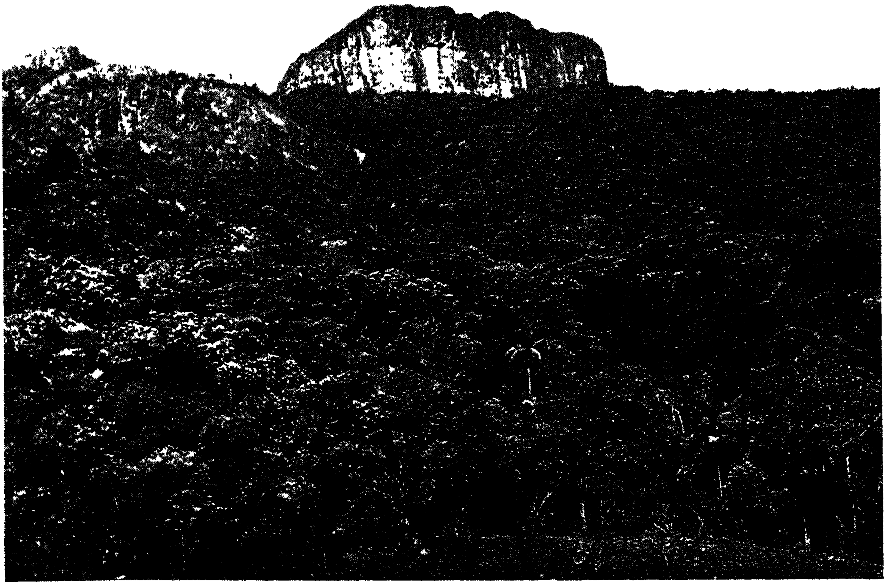

Fig. 24—Deciduous forest with scattered palms on the east slope of Cerro Yaví. Local savanna in foreground lies at 2475 feet. Note deforestation of high ridge on left side of photograph. In background, cliffs of the northern summit area.

Fig. 25—Typical view of the eroded sandstone on the summit of Yaví (7500 feet), with bunch grasses and dwarfed vegetation. (Compare with the summit photograph of Mt. Roraima, *Geogr. Rev.*, Vol. 20, 1930, Fig. 8, p. 65.)

FIG. 26—The northern summit area of Cerro Yaví, with prominent sandstone cliffs. In middle distance, eastern cliffs of Serranía Yutajé and on horizon, Cerro Guanay(?). (Photograph by G. Zuloaga.)

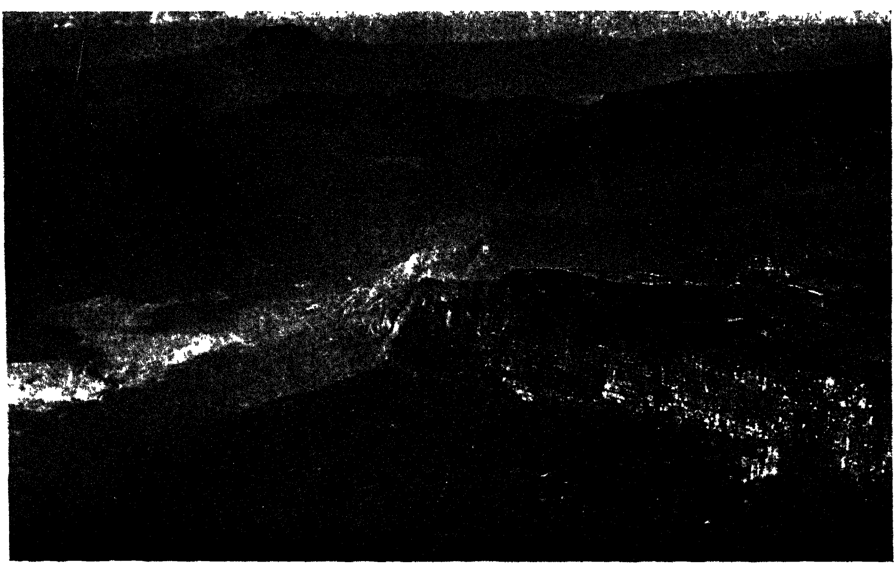

FIG. 27—Looking southwest across the south part of Serranía Yutajé toward Cerro Camani, the high point on the horizon. Lighter-colored area is savanna land. (Photograph by G. Zuloaga.)

higher levels on the mountain what had appeared at a distance to be grassland proved to be a dense growth of bracken, traversable only with difficulty. In one place the charred trunk of a large forest tree was lying in this growth. Such treeless areas occur on the ridges of Yaví nearly to the summit cliffs on the east side, facing the lowland savannas; in contrast, the northern and western slopes are heavily forested. So far as precipitation is concerned, the eastern slopes should receive as much or more moisture than the others. It is probable that fires started in the lowland have been the "savanna-making" agent on the Yaví slopes.

Twenty-five miles to the northeast of Yaví the foothill ridges of Cerro Calentura appeared to be similarly treeless, and it was said that those slopes also are annually fired by Yavarano Indians living in the headwaters area of the Parucito, though the Yavaranos of San Juan denied this. Perhaps the burning is done only for practical purposes, such as facilitating travel, driving game, or reducing the savanna ticks. Sometimes it may well be solely for the pleasure of watching a big fire. The surviving vegetation consists largely of coarse bunch grass and scattered chaparro trees.

Caño Platanal

From base camp, set up in flood forest on the right bank of the Parucito, Cerro Yaví was approached across a five-mile strip of savanna, above which ridges, largely grass-covered and trending northeast-southwest, rose abruptly 300 to 600 feet. In general, the course of the Caño Platanal, which heads in a large valley that separates the summit into two main parts, was followed.

An extraordinary feature of the Caño Platanal, thoroughly justifying its name, is a grove of wild plantains (Fig. 14), completely untended and of unknown origin. One of three remaining Guaiquiare Indians of the lower Manapiare, whose ancestors lived at "El Platanal," said that it "has always been there." Spinden has remarked that travelers may have gained the impression that the banana is pre-Columbian because it occurs in the wild state along many rivers of Central and South America. However, bananas were not found by the earliest Spanish and Portuguese expeditions. Spinden attributes the wild growths to plants that, "uprooted originally in Spanish settlements at the heads of streams and drifting down, found lodgment on mud banks."[10]

[10] H. J. Spinden: The Early History of the Banana, Part II, How the Banana Reached America, *Unifruitco*, July, 1926, pp. 738–741; reference on p. 740. Dr. W. E. Stafford of the U. S. Bureau of Plant Industry also strongly denies that any evidence of banana or plantain in ancient America exists (*Science Suppl.*, No. 1589, Vol. 61, June 12, 1925, p. xii).

The plantains of the Caño Platanal, a small tributary stream, cannot be far from their original location. No reference has been found to an early Spanish settlement in the region, but there are records of missionaries and of soldiers temporarily stationed on the upper Ventuari. A strange caravan of soldiers, Indians, and cattle traversed the Manapiare Valley in the mid-eighteenth century. At the instigation of Don José Iturriaga of the Spanish Boundary Commission the caravan left the lower Orinoco under the leadership of one Miguel Sánchez with the intention of driving the cattle south to the newly founded settlement of San Fernando de Atabapo. Everywhere the Indians fled in terror of the strange horned animals. Many hardships were endured, but the expedition finally reached its destination with a few starving cattle.[11]

Father Gili, in his discussion of the banana, says that the plant was spread rapidly by the Indians, who quickly appreciated its value as a food plant, and that they not uncommonly located their settlements close to their banana plantations. The secret of El Platanal may never be fathomed, but an Indian planting seems plausible.

The plants averaged 25 to 30 feet in height, and the largest measured had a girth of 33 inches at 2 feet above the ground. Fruit was abundant, in various stages of ripening; individual plantains were as much as 16 inches long. According to residents of the region, the banana or plantain under cultivation there will die out in five years if not properly tended, but at El Platanal new shoots were springing up wherever plants past bearing had fallen, and the ground was clean, with a surface cover of three or four inches of sandy loam underlain by coarse sands. Numerous dried stream channels showed that the plantation must be thoroughly flooded during the wet season. It was the belief of Melisio Pérez of San Juan that the annual flooding and moving of sands along these little channels over the surface of the ground tended to maintain the "cultivated" condition.

Slopes of Yaví

Westward from El Platanal, the ascent of the mountain began through small patches of savanna and forest, then up wooded slopes in a gradual climb to about 5700 feet, the height of the base of the summit cliffs of the mesa. On the lower slopes the trees were low and of no great growth. The humus cover was thin and the forest extremely dry. Leaves were falling, and when we returned, 11 days later, the woods, except for the lack of

[11] Gili, *op. cit.*, Vol. 3, pp. 123–126.

FIG. 28—Typical moss forest of the upper slopes of Yaví. (5700 feet).

FIG. 29—Vegetation at the summit camp. Mrs. Phelps in the foreground.

color, suggested midautumn in New England. The illusion was heightened by the presence of migratory birds from North America—redstarts and yellow warblers. At about 3900 feet the trees of the open forest locally were not taller than 30 feet. At about 4600 feet the change from tropical to subtropical vegetation was pronounced; there was a marked increase in humus content, and the trail was spongy to the tread in many places. Ferns, mosses, and orchids were more common, and numerous purple and yellow flowering trees not present at lower elevations were in bloom. Locally, in moister areas, the deciduous forest became tall and contained a considerable number of palms. At 5725 feet a camp (Zanjón Central) was established well within the valley separating the north and south parts of the summit

FIG. 30—View west from Yaví, taken at 7500 feet. Eroded sandstones of the summit in the foreground.

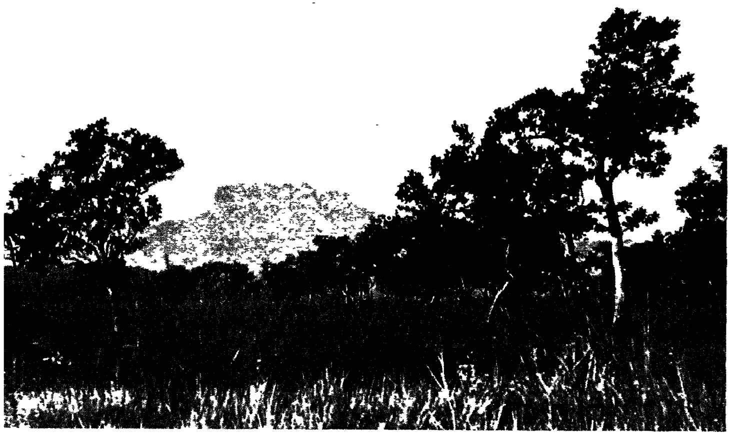

FIG. 31—Savanna of the Caño Parucito. Cerro Yaví 10½ miles to the northwest.

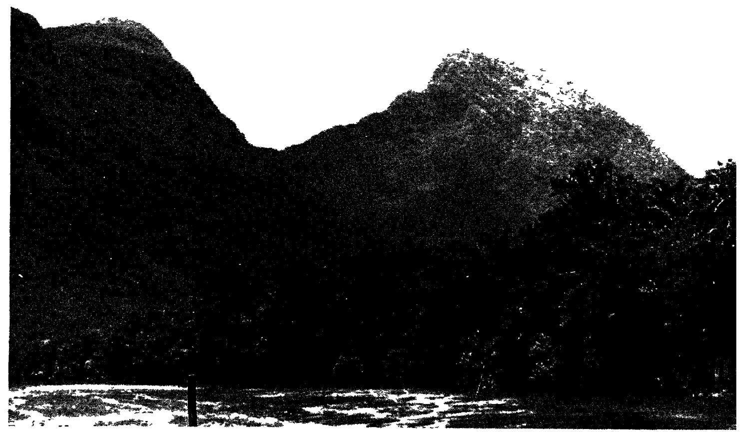

FIG. 32—Cerros Moriche, on the right bank of the Río Ventuari. Looking south

tableland. Here the trees were heavily clothed in moss, characteristic of the wet subtropical forest of the Guayana region (Fig. 28). During our stay, however, the forest was dry, and the only running water available was that of the Caño Platanal (temperature 59° F.).

The Summit

The approach to the north summit (Fig. 26) was up the western slope of a tributary valley trending northwest. There was relatively little rock climbing, and that largely across great blocks of sandstone, partly clothed in many places with large patches of pink and yellowish-brown moss. The summit camp was set up on a flat rock outcrop surrounded by rocks eroded into fantastic shapes reminiscent of views of the summit of Mt. Roraima. Locally, in depressed areas, the trees reached a height of 20 feet, but the vegetation was principally low and scrubby, with thick, succulent leaves—the type of forest referred to by Tate as *Bonnetia* forest.[12] Few plants were in flower. Bunch grasses covered much of the rockier areas where there was thinly covered residual sand and little humus. Depressions, obviously swampy in the rainy season, were now completely dried out. The only water available had to be dipped from a tiny pool (57° F.) in the dry bed of a brook. Remarkably, a small pond not accessible because of an intervening valley and cliffs was being maintained on the east side of the northern summit area.

With the exception of swifts of at least two kinds, which flew in great numbers high over the summit just before dark and roosted at night in the many caves, birds were relatively scarce and difficult to locate. One small brown lizard about two inches long appeared for a moment on the ledge rock.

From a height, looking west (Fig. 30), one saw a fantastic landscape. The dissected table mountains that had been visible in the distance during the reconnaissance flight appeared as a series of great jagged uplands set apart one from another by various intensities of purple and blue; in the foreground was the dissected summit area of Yaví, silhouetted in shades of brown and gray; in the middle distance was the broken summit of Serranía Corocoro, the northern part having about the same altitude (leveled by Brunton) as Yaví. Some 34 miles to the northwest, and with about the same elevation, the great cliffed mountain (Cerro Guanay?) in the headwaters area of the Caño Guaviarito rose along the watershed between the territory of Amazonas and the state of Bolívar. To the west-southwest was the lower, dis-

[12] Tate, Auyantepui (*op. cit.*), p. 459.

sected, and heavily wooded upland over which the first air reconnaissance had been made. To the south the distant view was cut off by the southern summit area of Yaví, so that the prominent Cerro Camani (Anaitya) could not be seen. To the northeast the outstanding feature was Cerro Calentura, at the headwaters of the Parucito, 25 miles away, with long, ridged foothills similar to those of Yaví, but with a somewhat lower crest; to its east was the beehive-shaped Cerro Campanero. Eastward, the sky was gray with smoke from the burning lowland savannas, but beyond the savannas of the Parucito the country appeared as a series of dissected, forested mountains trending northeast-southwest to the horizon. In the extreme distance was a prominent range with two rounded peaks higher than Yaví. The dissected, mountainous country of the middle distances is, however, considerably lower.

Settlements

Settlement in the Orinoco-Ventuari region is largely marginal. There are only two towns, San Fernando de Atabapo, former capital of Amazonas Territory, founded in 1756 by Iturriaga and Solano, members of the Spanish expedition to establish the boundaries with Portugal,[13] and Puerto Ayacucho, present seat of the federal government, founded in 1928. Other settlements consist only of single houses or groups of houses constructed of mud and palm thatch; most of them are located along the Orinoco between the Maipures Rapids and San Fernando. At the time of the 1941 census, Puerto Ayacucho had a population of 856. In addition to a mission school, there are several government buildings, including a modern hospital, and a few stores, which are stocked with general merchandise and carry on trade in products of the region. The town is supported largely by the operations of the federal officials and their assistants. Relatively little agriculture is practiced, except by the mission, and much of the food must be imported.[14] Situated at the head of steam navigation on the Orinoco, just below the great rapids, the capital is marginal to the Territory. It does not enjoy the central location of San Fernando de Atabapo at the junction of three rivers, which Humboldt pointed out[15] as being "similar to that of Saint Lewis or

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[13] Caulin, *op. cit.*, p. 76. According to Humboldt and also Demetrio Ramos Pérez (El tratado de limites de 1750 y la expedicion de Iturriaga al Orinoco, Consejo Superior de Investigaciones Cientificas, Madrid, 1946, pp. 298-300), San Fernando was founded by Solano. The latter study, received since completion of this article, draws extensively from manuscript material by the boundary commission in Spanish archives.

[14] More than 50 per cent of the food for the Territory is imported ("Tribus indígenas de la Prefectura Apostólica del Alto Orinoco," Comité Organizador, Tercera Conferencia Interamericana de Agricultura, Caracas, 1945, p. 26).

[15] Humboldt, *op. cit.*, Vol. 5, Part 1, p. 201.

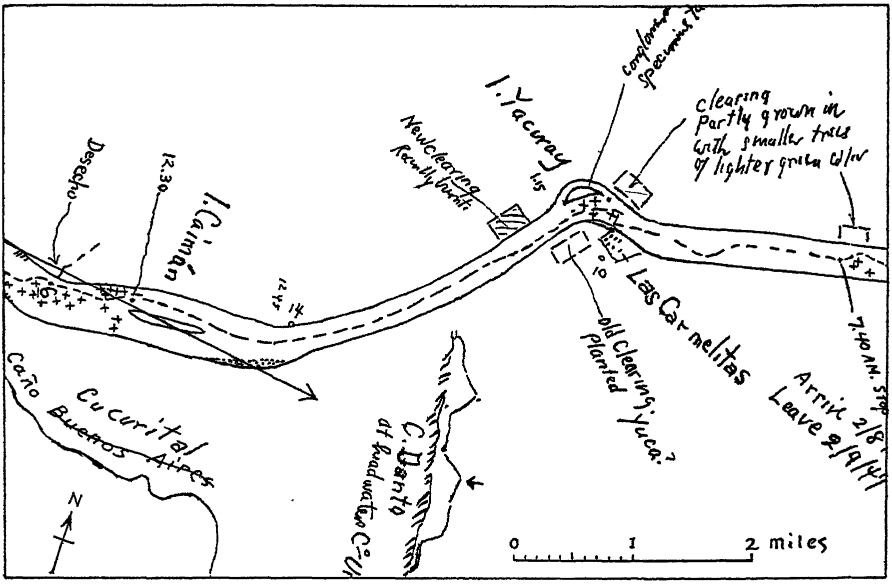

FIG. 33—Section of field map on reduced scale (original scale 1:80,000). Río Ventuari at Yacuray (Las Carmelitas).

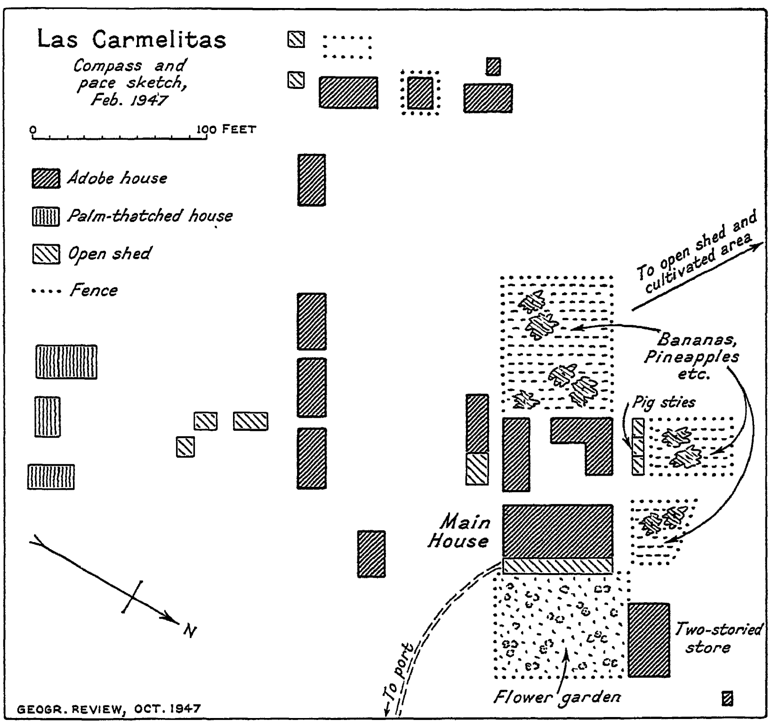

FIG. 34—The settlement of Yacuray (Las Carmelitas). Redrawn from pace and compass sketch.

of New Madrid, at the junctions of the Mississippi with the Missouri and the Ohio."

San Fernando has had many fluctuations in its population and prosperity. It was initially an Indian settlement, whose chief befriended the Spanish engineers. On the death of its chief and in the absence of Solano, it was abandoned, but it was later re-established by a vigorous governor, Don Manuel Centurión, and populated with Indians from the Guaviare and the Vichada. When Humboldt visited it in 1800, it had a population of 226[16]—a figure said to have been exceeded in the years immediately following its selection as a mission. In the 1880's the population was still approximately 200.[17] During the rubber boom, which lasted until 1908, the population is said to have increased to 2000. Koch-Grünberg, in 1913, estimated the inhabitants at 400 to 500 during the summer, when part of the population were away tapping rubber, and about 1000 in the winter.[18] What with local revolutions, the decline in rubber, and the change in the seat of government, the population dropped to less than 150 in the early 1940's. Return of the territorial government to San Fernando was a frequent topic of conversation in Puerto Ayacucho in early 1947. Geographically, as was pointed out above, San Fernando's location in a more central part of the Territory is far superior to the present site for a seat of administration. There is some activity in chicle, balata, rubber, and other products of the region. Rubber production, however, has declined seriously since the withdrawal of the Rubber Development Corporation at the end of the war.

Many early settlements of the Orinoco have fared badly. For example, Santa Bárbara, near the mouth of the Ventuari, has for years been no more than a point of reference for travelers. Santa Bárbara was founded in the latter part of the eighteenth century by a Capuchin monk from Andalusia with Indians removed from the Rio Negro in Brazil; at the beginning of the nineteenth century it had grown to a settlement of 120 persons. According to Humboldt, it had "some traces of industry," but largely for the benefit of the monks, not the natives. When the site was visited by Chaffanjon in 1887, no houses were standing. Somewhat later, two houses were rebuilt; but when the writer visited the site in 1928, there were no houses, and only a few mango trees attested to a former settlement; it was the same in 1947.

[16] *Ibid.*, p. 200.

[17] J. Chaffanjon: L'Orénoque et le Caura: Relation de voyages exécutés en 1886 et 1887, Paris, 1889, p. 208.

[18] Theodor Koch-Grünberg: Vom Roroima zum Orinoco: Ergebnisse einer Reise in Nordbrasilien und Venezuela in den Jahren 1911–1913, 5 vols., Berlin, 1917–1928; reference in Vol. 1, p. 395.

FIG. 35—Navigational difficulties on the Río Parucito.

FIG. 36—Yavarano Indian, with *payara*, just speared with pointed stick; typical dugout.

FIG. 37—The welcoming crowd at San Juan.

FIG. 38—Sr. Melisio Pérez, founder of San Juan.

FIG. 39—San Juan on the Manapiare.

A contrasting picture is presented by Yacuray, or Las Carmelitas, the only Venezuelan settlement on the Ventuari. This town was founded by a Venezuelan, Rafael Federico (Chicho) González. As a result of reasonable treatment of the Indians, he not only obtained labor from the Ventuari and its tributaries but, according to Koch-Grünberg, who visited him earlier, he had also natives from the Guaviare, the Inirida, the Vichada, and the Atabapo, and even one from the distant Vaupés. Yacuray has been in existence since 1921 and now comprises more than 20 buildings, including sheds, laid out in orderly fashion (Fig. 34). The large main house has the luxury of cement flooring. There is a two-story store where most of the necessities of life can be purchased. It is said that during the war, when the Rubber Development Corporation and the United States Army Engineers were stimulating activities in the Orinoco region, supplies unobtainable in San Fernando de Atabapo were shipped from Yacuray to fill the demand. The settlement is equipped with a small electric plant, a kerosene refrigerator, and other articles of modern living. At the time of our visit there was no sign of great activity, and several of the houses were unoccupied, perhaps as a result of the sudden loss of interest in rubber. The present owner, a

son of Chicho González, also maintains a house in Puerto Ayacucho, just as his father did in San Fernando de Atabapo.

Bananas, plantains, yucca, sugar cane, and other crops of the region are grown, and, in addition, excellent limes. Livestock consists of chickens and pigs. People from Yacuray formerly raised some cattle on the left-bank savannas some miles below the town. Maintenance of a settlement such as this in pioneer country on an otherwise unsettled river requires the guidance of a strong individual with understanding and energy, for the life is not an easy one. The Orinoco region, above San Fernando at least, is unquestionably in the process of depopulation at the present time. San Antonio, 55 miles above the mouth of the Ventuari, is reported to have been recently abandoned after the death of its owner; Tamatama is also deserted; and Esmeralda, the farthest settlement on the Orinoco, has been unoccupied since its inhabitants fled after westward incursions by the Guaharibo Indians from the Orinoco headwaters. A Brazilian in the employ of the Rubber Development Corporation during the war encountered Guaharibos in the foothill forests of Duida and Marahuaca, and they have been reported to be also along the left bank of the upper Casiquiare.

In the entire Ventuari basin there is only one other settlement, San Juan, established by Sr. Melisio Pérez two years before our visit on the right bank of the Manapiare a mile below the mouth of the Caño Parucito. It consists of six thatched houses. A short distance upstream Indians associated with the enterprise have established a small village. In all, the settlement contains about 60 people, including four Brazilians and three Venezuelans working under Señor Pérez, who are engaged part of the time in the collection of *sarrapia* (tonka beans), chicle, and balata. Bananas, plantains, sugar cane, yucca, maize, and other crops are cultivated. One hundred quintals of maize was exported to San Fernando de Atabapo during the year. Crops are said to grow with ease; seed is supplied by the government, which also subsidizes purchase of the crop. The thickest and best-prepared cassava cakes seen in the region were made here. There seems to be no doubt that agriculture, if undertaken with a proper regard for terrain, can be carried on successfully in this area, but cultivation of steep slopes might well result in extensive soil erosion during the rainy season. In the Manapiare region, hillsides that had been denuded of trees were found to be rocky, devoid of topsoil, and of no agricultural value. At the present time the raising of livestock is impracticable because of the large number of jaguars. Abundant fish and wild game supply the dietary needs. A small supply of useful trade goods—cloth, matches, hooks, line, and so on—is kept on hand.

The Indians

Most of the Indians of San Juan belong to the Yavarano tribe.[19] They appeared healthy and well fed and were a cheerful lot. Several of them later carried heavy loads for us from the upper Parucito to Cerro Yaví. They liked such sensible articles of trade as cloth (particularly red and blue), ready-made pants, cotton shirts, *alpargatas*, fishhooks, and knives and showed little interest in such things as beads, mirrors, and perfume. Most of them spoke Spanish but conversed among themselves in their own language.[20] Formerly there were a number of Guaiquiaris in the region (the Wökiáris of Koch-Grünberg), but at the present time only three are said to be left, one of whom was at San Juan on our return. There are also a few Indians of the Horachicana tribe (the Kuraschikiana of Koch-Grünberg).

In fairness to these likable people it seems well to give categorical denial to a rumor circulated while we were in the field that the expedition had been attacked by savage Indians and some of the personnel killed. The source was an incorrectly interpreted radio message; it made good copy for the local papers and eventually reached the United States dailies as a United Press dispatch. At the time, field plans were proceeding according to schedule, and several very helpful and friendly Indians were assisting us in the transportation of material to and from Cerro Yaví. On March 3, when we were on the summit, a plane was first seen flying northward up the valley of Caño Parucito. A smoke smudge was started but went unnoticed by the plane, since many savanna fires were burning. Four days later, as we were going downriver (Fig. 9), the plane returned, and, locating our boats on the river, dropped numerous small white cards instructing us what to do in case of trouble. With these cards Mr. Phelps had the presence of mind to spell out a large O.K. on the blackened savanna! On both these flights the plane was under the command of Colonel Douglas Williams, chief of the United States air mission. To him and his crew, and also to Dr. Guillermo Zuloaga, chief geologist of the Creole Petroleum Corporation, who went along on the second flight, we owe a debt of thanks. Their investigation of the rumor was made at some risk, since the plane necessarily covered country where a forced landing would have meant disaster.

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[19] According to Koch-Grünberg, the Yavaranos are members of the Carib group and speak a distinctive dialect.

[20] Humboldt said of the Indians of the Casiquiare that "they display, while in the missions, intelligence, some love of labour, and in particular a great facility in learning the Castilian language" (*op. cit.*, Vol. 5, Part 1, pp. 430–431).

FIG. 40

FIG. 41

FIG. 42

FIG. 43

FIG. 44

FIG. 45

FIGS. 40–45—Indian types at San Juan; Yavaranos (Figs. 40, 41, and 43), and Guaiquiari (Fig. 42). Albino baby with mother (Fig. 44).

The San Juan Indians are under the leadership of a chief or *capitán,* who took great pride in showing a typewritten document officially designating him as leader.[21] The *jefe civil* of a department has the authority to appoint the Indian *capitanes.* There is apparently no necessity for him to consult the Ministry of the Interior in Caracas or the president of the state (or governor of the territory). The chiefs are usually permitted to carry arms. Whenever punishment is meted out to an Indian, it is administered by his capitán.[22] Incidentally, the jefe civil also has the right, under similar conditions, to appoint the Venezuelan *comisario,* a sort of minor jefe civil in rural districts.

When Koch-Grünberg, on December 22, 1912, reached the vicinity of the Manapiare, he was met by two canoes filled with fully dressed Yavaranos accompanied by their chief, who addressed the traveler in good Spanish and politely asked him who he was and where he was going. The Indians were in poor health, from ill treatment received from a Venezuelan with headquarters on the Orinoco. Rather than seek nearness to civilization, they had burned their village and were about to retreat into safer country. Thus it has been with the indigenes of the region. In the eighteenth century Carib Indians under commission from the Dutch of the Essequibo periodically entered the Manapiare region from the north, crossed the savannas, and carried away the natives as slaves—"a leaded file, which without being heard, goes on consuming the inhabitants of this land."[23] Although most of the Indians have moved into less accessible country, many still live their normal lives along the lower Cuao and other streams near the capital, and within 30 miles of the airfield at Puerto Ayacucho.

Along the Manapiare and the Guaviarito there are probably no more than 500 Yavaranos and only a handful of Guaiquiaris. In the headwaters area of the Caño Guapuchí there are from 200 to 250 Macus, in the headwaters area of the Parguasa a few Mapoyos, in the entire region of the Sipapo and its tributaries (according to Señor José Sué of San José, who is best acquainted with that region) about 2000 Piaroas, and on the Cataniapo and other streams near Puerto Ayacucho some 200 to 250 Piaroas. A rough estimate of the total Indian population would not exceed 3000, and this may well be an optimistic figure.

Natural Resources

Except for rubber along the upper Orinoco and the Ventuari, chicle,

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[21] This document carried by the capitanes seems to have had its origin at the time of the early Spanish explorers.

[22] Information from Señor González Adám, through Mr. Phelps.

[23] Caulin, *op. cit.,* p. 67.

sarrapia (tonka bean), and balata, few of the natural resources are exploited. Sarrapia, the crystallized extract of which is used chiefly in flavoring tobacco and, to a smaller extent, in the preparation of artificial vanilla extract, is collected in the dry season. On March 6 we passed a dugout from San Juan carrying two men, one a Venezuelan and the other an Indian, a woman, a little boy and girl, a small white dog sitting amidships on a basket of cassava, and hammocks and other travel necessities. The group were on their way upstream to collect sarrapia, though for the best results in collecting they should have left in January. This detail is cited as representing a rather typical scene. The exploitation of sarrapia is under the jurisdiction of the Banco Agrícola y Pecuario, an autonomous government bank. When the explorer has found a good stand, he communicates with the *comisionado especial de la sarrapia,* a bank employee resident in Ciudad Bolívar, indicating the area he wishes to exploit. Obviously, however, there cannot be close control in the back country. Extraction of the essence from the beans, formerly done in Trinidad, now takes place in Ciudad Bolívar. Little attempt has been made to start sarrapia plantations in the Territory, though the feasibility of such an undertaking is indicated by the luxuriant growth of the sarrapia trees planted around the plaza of San Fernando and, in particular, by the success of the small plantation recently started at San José by Señor José Sué. Expansion of such plantations should provide a considerable income to industrious residents of the region.

Balata concessions are obtained similarly to the sarrapia concessions, but from the Dirección Forestal of the Ministerio de Agricultura y Cría; they provide exclusive rights to an area of not more than 1000 hectares for a period of one year.

One other exploited resource, alligators, deserves mention. An example will suffice to illustrate this business. In the dry season of 1947, three men obtained 58 alligators on the Ventuari, capturing them at night by the use of a powerful electric flashlight and harpoons. The skins, of which only the belly portion is utilized, averaged eight feet in length and were paid for at the rate of five bolivars ($1.65) a foot. The gross return per man averaged about 13 bolivars (approximately $4.25) a day.

Transportation

Except for the 40-mile stretch of well-maintained, gravel-surfaced road from Puerto Ayacucho, the upstream terminus of steam navigation, round the great Atures and Maipures Rapids of the Orinoco to Sanariapo, Amazonas Territory is without good roads. An extension of this road south to the

small settlement of Morganito has been proposed and if constructed would afford an all-year port at the upstream end of the portage. Some work has also been done to extend the road northward to the Bolívar boundary, and some temporary wooden bridges have been built. The route traverses savanna country for the most part and so far as grading is concerned offers no great problem. Sanariapo is a poor port, some 2000 feet above the mouth of the tributary stream of the same name. It is unusable during the dry season, and larger boats must tie up near the mouth of the stream. When we passed through on March 13, the "port" was a small stream no more than 10 feet wide and less than 2 feet deep. Furthermore, the waters of the Orinoco are swift at the mouth of the Caño Sanariapo near the head of the Maipures Rapids.

Travel throughout the region is essentially by water—launch, falca, and smaller dugouts. The transportation "revolution" that impressed the writer was the introduction in the last 20 years of the outboard motor; a number of falcas now have specially constructed sterns to accommodate these motors. Mechanized travel is still largely marginal to the Orinoco-Ventuari region and would in any case be restricted by the numerous rapids and falls in many of the major streams.

The Río Sipapo and its tributaries the Autana and the Guayapo are the most important arteries of access from the west; the Cuao tributary is obstructed by rapids in its lower course. In the wet season the Sipapo can be ascended by motorized falca as far as the Caño Aracapa in four days. From the east, access is by the Ventuari and its tributaries the Guapuchí and the Manapiare. None of the people questioned had ever attempted an ascent of the Marieta.

Humboldt's comment of more than 125 years ago still stands: "In the centre of these savage countries, where there will long be no other road than the rivers, every project of civilization should be founded on an intimate knowledge of the *hydraulic system*, and the relative importance of the tributary streams."[24] The Indians travel long distances by water, with short trail connections from one stream system to another. We were told of a short trail from the headwaters of the Marieta to the Caño Mavaco at the headwaters of the Río Autana, and another from the upper Cuao to the Caño Maravacá on the northward drainage of the Río Parguasa. Undoubtedly there are many others, not yet recorded. For example, at San Juan there was a Piaroa who had just arrived from the upper Cuao.

The approximate locations of a few trails are given on the accompanying

[24] Humboldt, *op. cit.*, Vol. 5, Part 2, p. 608.

map. Not shown, since they are beyond the map limits, are the old slave route from the Manapiare system to the Caura and the three-day trail (Pica Túriva) from the headwaters of the Parucito to those of the Cuchivero.

In contrast with the primitive pattern of travel just described is the airfield at Puerto Ayacucho, with plane service three times a week to Maiquetía Airport, the principal field for Caracas. From Maiquetía, New York and Europe are only a few hours away.

Preliminary reports on the ornithological and geological collections are given below together with notes on climatic data. Mrs. Phelps and the writer made a botanical collection, and the specimens are now being studied by Dr. Tobias Lasser of the Servício Botánico in Caracas and Dr. Bassett Maguire of the New York Botanical Garden. A report on their findings will appear in a subsequent number of the *Geographical Review*.

THE ORNITHOLOGICAL COLLECTIONS

WILLIAM H. PHELPS, JR.

Collections representing fairly complete samplings of the avifauna were made on the eastern slope of Yaví, "Falda Oriental," on the summit, "La Cumbre," and at Las Carmelitas. Other collections, averaging less than two birds per species, were made at provisional camps established primarily for the organization of the ascent of Yaví and during the ascent itself. From the "Falda Oriental" station (1400 meters) collecting trails were cut to the base of the eastern cliffs (1900 meters), and from the "Zanjón Central" camp (1800 meters) collecting was carried on, with and without the aid of trails, up to 2000 meters.

The collections on Yaví, as shown in Table I, confirmed the experience of our previous explorations of the great sandstone plateaus of the Venezuelan Guayana. We found that it was not necessary to reach the summit in order to obtain a fairly thorough sampling of the subtropical avifauna; a good representative collection can be made in the cloud forest that covers the talus up to the base of the cliffs. A satisfactory botanical collection, however, can be made only on the plateau, for there only is to be found the climax of a flora with marked endemism. The natural desire to establish camp on terra incognita and to collect the few birds that are found only on top has driven us always to attempt to reach the summits of the table-top mountains we have explored. We failed to reach the plateau of only one—Ptari-tepui, a 2450-meter mountain in the Gran Sabana protected by continuous perpendicular or overhanging 300-meter cliffs that can be scaled only by helicopter.

Of the 40-odd subtropical species collected on Yaví, slightly more than half belong to forms generally distributed throughout the Venezuelan Guayana highlands; about one-fourth are forms found on Cerro Duida, Cerro Sipapo (Paraque), or both; three or four subspecies have been found only on the *tepuis* of the Gran Sabana; and at least six new subspecies have been identified and are being described from types collected on Yaví itself, four of which are endemic to Yaví; the other two are found on Sipapo also.

Six subtropical birds have been found only on Cerros Sipapo and Yaví. The fact that these show no appreciable difference though found more than 200 kilometers apart suggests

the probable existence of the same biotope in the intervening region, where, consequently, there should be found an almost continuous series of mountains not much lower than 1000 meters.

As the study of the collection progresses, additional forms will probably be found that deserve subspecific status, but the more important, though less spectacular, contribution to ornithology lies in the main body of the collection, with its 280 different species. These help to clarify many problems pertaining to the distribution of the tropical and subtropical avifauna of the region.

TABLE I—ORNITHOLOGICAL COLLECTIONS OF THE EXPEDITION

Stations	Number of specimens	Number of species	Species not collected at other stations
El Platanal, Caño Parucito (200 m.)	127	71	31
Caño Platanal, Falda Oriental (500 m.)	101	50	14
Falda Oriental (1400–1900 m.)	245	54	25
Zanjón Central (1800–2000 m.)	49	22	0
La Cumbre (2100–2300 m.)	96	18	3
Las Carmelitas (120 m.)	626	172	121

Total number of specimens, 1244; total number of species, 280.

GEOLOGICAL OBSERVATIONS

CHARLES B. HITCHCOCK

Wherever the itinerary permitted examination of the rocks along the route between Puerto Ayacucho and San Fernando de Atabapo, they were found to be granite, often coarsely crystalline. For at least 20 miles east of the Atures and Maipures Rapids the hills have the rounded, sugar-loaf shape characteristic of granitic weathering. Evidence suggests the presence of a great granite batholith in this area. In the Santa Bárbara Rapids and on the lower Ventuari as far as the settlement of Yacuray, the basement was also granite, of coarse to medium texture, and pinkish in color.

At Yacuray, large blocks of well-rounded conglomerate of firmly cemented quartzite and quartz pebbles rest upon syenite outcrops in the river bed, but no direct contact was noted. The basement rock is cut by three joint systems, the most prominent of which strikes N 70° E. Both syenite and conglomerate are cut by a series of thin quartz veins that commonly follow the predominant joint system.

Upstream from Yacuray as far as the mouth of the Manapiare, the rocks examined were granitic or porphyritic, except in the vicinity of Cerros Moriche. Here there are outcrops of very dense pink quartzite, which has taken on a marked polish or veneer of a yellowish-brown color where exposed to the river. No structure was noted in the two outcrops examined, but the course of the river within the belt of quartzites follows an almost rectangular pattern, in contrast with the irregular course in the area of igneous rocks. Along the Manapiare as far as the mouth of the Parucito outcrops were fewer and largely gneissic. In the lower Parucito the stream is held up in four small rapids by a weathered

oölitic material resembling limonite but not positively identified as such. Elsewhere along this stream as far as the final stop only two weathered outcrops were noted, one of which proved upon thin-section examination to be a sandstone.

West of the base camp on the Parucito a number of long parallel hills rise abruptly several hundred feet above the savanna. Where examined, the rock was jointed and shattered. The color is pink, and the texture ranges from fine-grained to porphyritic. Locally a three-foot bed had weathered to a fine, powdery material. This rock was not identified in the field but is described in the following report by Mr. Galavis as a rhyolite or dacite. The rock showed a definite structural trend varying from N 42° E to N 55° E in the hills near base camp. The rhyolite there is cut by numerous quartz veins, some of which are more than six feet in width. Similar hills, not examined on the ground, extend northeastward for 25 miles. In the headwaters area of the Caño Guapuchí, it may be noted, are other hills, which from the air have a topographical expression resembling those of the Parucito.

The lower, gentler slopes and ridges of Yaví are underlain by intrusive igneous rocks, diorite and granite, in close association, to a height of 4840 feet. Above, only sandstones and interbedded conglomerates were noted. Fine-grained granite outcrops in the bed of the Caño Platanal at 950 feet (sample 16), and dark-gray, massive diorite at 1375 feet; the diorite is apparently continuous upstream to nearly 2475 feet. At this elevation loose, angular blocks of conglomerate and pinkish quartzitic sandstone were spread over the surface of a small savanna, but none was found in place. Pebbles in the conglomerate were angular to rounded, averaged less than one inch in diameter, and were composed chiefly of pink quartzite and white quartz, with smaller quantities of diorite. There was no macroscopic difference between the diorite in place and that composing the pebbles, and it is assumed that these sandstones and conglomerates postdate it. How far the loose blocks had traveled could not be determined.

At 4500 feet granite was found and was followed up the steep bed of a small, nearly dry stream for about 600 feet. The stream drops in small waterfalls and cascades over a series of steps, the treads of which dip gently into the mountain. This was not a sheeting structure related to the contour of the mountain, a characteristic of granite when exposed to alternate atmospheric heating and cooling; more likely it is due to tension cracks resulting from differential stress within the granite itself, a feature expectable near the top of a granite intrusive. The granite is moderately coarse-grained. At 4840 feet the stream profile flattens out and the granite is succeeded by great angular blocks of interbedded conglomerate and sandstone cut by narrow quartz veins. Although no contact was noted, it seems safe to assume from the existing conditions that it lies at this point.

Pebbles in the conglomerate, more than a hundred of which were examined, were found to be pinkish or gray quartzite, or, more rarely, a white quartzite with thin brown laminae, or quartz. The cement was moderately quartzitic. No pebbles of the underlying granite could be found. Absence of pebbles of the underlying rock is not necessarily disproof of unconformable relationship. The local deposition of far-traveled quartzites on a clean-swept granite surface is conceivable. Although the relationship between the granite and the conglomerate is not clearly demonstrable from the conditions observed, it may be said that both the sheeting of the granite and the absence of granite pebbles in the conglomerate are expectable if the granite is a local intrusive, and thus younger than the overlying sedimentaries. In a general article on the geology of the Venezuelan Guayana, Zuloaga com-

ments that granites and gabbros are commonly found in close association.[25] "If the granitic and gabbroic rocks are contemporaneous, both are more recent than the rocks of the Roraima Series [the sandstones and conglomerates], since the rocks of the basic group are found cutting the rocks of this series."

In the Gran Sabana region of the Guayana, where the sandstones appear in general to be lithologically and structurally similar to those of Yaví, pebbles of an underlying porphyry are common in the basal conglomerate and are good evidence of unconformable relationship.[26]

From the contact (4840 feet) to the summit only sandstones and interbedded conglomerates were observed, and conglomerates were rare above 6000 feet. The sandstone ranges in texture from fine to coarse-grained, is pinkish to gray in color, and is locally highly silicified, breaking with difficulty. Cross-bedding is characteristic. Small current ripples were observed in only a few places. Mud cracks were found in a 0.5-centimeter layer of shaly sand exposed on the side of a large upended boulder. In one place a foot of the finer sandstone was locally contorted, but overlying and underlying beds were undeformed. Local slumping previous to consolidation could account for this. The interbedded conglomerates were locally found to lense out rapidly horizontally. The coarser material ranges from cobbles eight inches in diameter in the lowest horizons to small, rounded, and subangular material. The material is generally pinkish to gray quartzite; well-rounded quartz pebbles are common in some horizons.

The sandstones of the summit area of Yaví, the cliff-forming beds, are gently inclined to the south; the maximum dip recorded was 5°. They are strongly jointed. The most prominent joints trend east-west, and three others of decreasing prominence trend N 50°–55° E, N 30°–35° W, and N 5° W respectively. As a result of weathering and erosion along these joint systems, the summit area is cut by numerous deep crevasses and valleys, including the large valley trending east-west that carries the headwaters of the Caño Platanal. The total thickness of sandstone above the granite is about 2750 feet.

PETROGRAPHY OF THE ROCK SPECIMENS

FELIX A. GALAVIS S.

Thin sections of the specimens of igneous, metamorphic, and sedimentary rocks collected were prepared in the Geological Laboratory of the Creole Petroleum Corporation and were studied by the writer. Following is the petrographic description of each type of rock. The locations of the specimens are shown on Plate II.

Igneous Rocks

Granite (Samples 2, 3, 4, 9, 10, 19, 26, 30, 31, 32, and 33). The rock varies in color from light to dark mottled pink and has a coarse granular to medium-grained texture. Microscopically it shows in part a micropegmatitic texture, due to the intimate intergrowth of quartz and feldspar. When present, the micropegmatitic texture constitutes about 80 per cent of the rock. The feldspar is microcline and microperthite with the exception of a

[25] Guillermo Zuloaga: Geología general de la Guayana Venezolana, *Rev. Colegio de Ingenieros de Venezuela*, Vol. 6, 1930, p. 475.

[26] S. E. Aguerrevere and others: Exploración de la Gran Sabana, *Revista de Fomento*, Vol. 8, 1946, pp. 129–231; V. M. Lopez, E. Mencher, and J. H. Brineman, Jr.: Geology of Southeastern Venezuela, *Bull. Geol. Soc. of America*, Vol. 53, 1942, pp. 849–872.

small percentage of free orthoclase and oligoclase. The quartz generally shows stress effects (wavy extinction). The main accessory minerals are hornblende and biotite, which constitute 10 per cent of the rock. In some cases (samples 10 and 33) the hornblende forms 20 per cent of the rock, and in many cases it is altered to biotite. Minor amounts of zircon, fluorite, magnetite, ilmenite, and apatite are present.

Syenite Porphyry (Sample 6). The rock is light greenish-gray in color, with phenocrysts of orthoclase in a fine-grained holocrystalline groundmass. Microscopically the rock is formed of a very fine-grained groundmass composed of orthoclase and quartz. The phenocrysts are orthoclase, in some cases altered to kaolin. A small amount of plagioclase is present. The main accessory minerals are biotite, magnetite, and zircon.

Diorite (Samples 11 and 17). The rock is dark gray to dark brown in color and megascopically has an equigranular texture, medium to fine-grained in size. Microscopically the rock is holocrystalline with a hypidiomorphic texture and is composed chiefly of andesine and hornblende, which together constitute 90 per cent of the rock. The main accessory components are orthoclase, zircon, pyrite, magnetite, and ilmenite(?). Quartz was not identified, but very small grains making up less than 5 per cent of the rock were observed and look very much like quartz. Secondary minerals, kaolin and sericite, were observed.

Dacite or Rhyolite Porphyry (Samples 8, 14, and 15). The rock is pink in color and megascopically has a porphyritic texture; suggestions of flow lines were noted. It decomposes to a white powder (kaolin or sericite). Microscopically it has a porphyritic texture with incipient spherulitic structure. The groundmass is composed of quartz and unidentified feldspars. The phenocrysts are chiefly andesine, but a few quartz phenocrysts are present. The feldspars and quartz of the groundmass constitute about 60 per cent of the rock. Oxides of iron are also present in phenocrysts but are of small size and very scarce. The accessory minerals, hornblende and biotite, are highly altered. Zircon is also present. The secondary minerals are kaolin, sericite, and chlorite(?).

Quartz Monzonite Porphyry (Sample 25). The rock is dark gray in color, with phenocrysts of white feldspars. Microscopically it has a porphyritic texture with a very fine-grained, holocrystalline groundmass. The groundmass is composed chiefly of microcline, orthoclase, plagioclase, and quartz. The phenocrysts are microcline, orthoclase, and plagioclase (andesine or oligoclase). The orthoclase-microcline percentage is equal to, or slightly higher than, the acid plagioclase percentage. Quartz constitutes less than 10 per cent of the rock. Highly altered hornblende and biotite are present in small phenocrysts. The accessory minerals are ilmenite, leucoxene, magnetite, and zircon(?). Kaolin and sericite are present as secondary minerals.

Muscovite-Biotite Granite (Samples 5 and 16). The rock is light pinkish-gray in color and has a very fine-grained texture. Microscopically the rock is very fine-grained and is composed chiefly of quartz and orthoclase. Microcline and microperthite are present and constitute 20 per cent of the rock. The quartz grains show stress effects and when large have very irregular borders. Muscovite and biotite occur and together constitute 10 per cent of the rock. The main accessory minerals are hornblende and zircon. The secondary minerals are kaolin, sericite, and chlorite(?).

Metamorphic Rocks

Granite-Gneiss (Samples 12 and 23). The rock is yellowish-white in color and has a gneissic texture. Microscopically it has the same composition as a granite. The orthoclase

and quartz grains are elongated and arranged in a gneissic texture. The quartz shows a very pronounced wavy extinction. The orthoclase and plagioclase are greatly altered. Accessory minerals are ilmenite, magnetite, zircon, muscovite, and biotite. The secondary minerals are kaolin, sericite, and quartz. No metamorphic minerals were observed, a fact that suggests a very incipient metamorphism at shallow depth.

Sedimentary Rocks

Sandstones (Samples 20, 20A, and 21). These samples were collected on Cerro Yaví. They are gray to pink, fine- to medium-grained, well-cemented, hard, slightly quartzitic sandstones. Series 21 is described according to the level from which the sample was taken: 1520 meters, grayish-pink, medium-grained sandstone; 1800 meters, grayish-pink, medium-grained sandstone; 1900 meters, pink, fine- to medium-grained sandstone; 2000 meters, gray, fine-grained sandstone; 2120 meters, light-pink, very fine-grained quartzitic sandstone; 2160 meters, dark-pink, very fine-grained quartzitic sandstone; 2285 meters, conglomeratic sandstone with siliceous cement.

Only two thin sections were made of these sandstones, and microscopical examination showed them to be composed of 95 per cent quartz; the remaining minerals are feldspar and mica (muscovite?). Both these thin sections show grains that are subangular to subrounded, and both are fine-grained sandstones cemented with secondary quartz and iron oxides.

Sandstone (Sample 22). This sample, collected from one of two outcrops along the bank of the Caño Parucito, is a sandstone of similar appearance to the foregoing.

Sandstone (Sample 27). This sample, collected from the alluvial fan made by a small stream on the right bank of the Ventuari, was presumed to derive from the Cerros Moriche. Megascopically the rock is a light- to dark-gray, very fine-grained sandstone with typical cross-bedding. Microscopically it consists of fine to medium subrounded to subangular grains cemented by quartz (secondary). It is composed chiefly of quartz (96 per cent), feldspars, and mica.

Quartzite (Samples 26, 28, 29). The rocks are pink in color, very dense, hard, and show a very marked polishing on the surface exposed to river-water action. Microscopically the quartzite shows the quartz grains highly distorted (grains are fractured and crushed). The wavy extinction of the quartz is very marked in the few grains that still have thei original shape.

CLIMATE

CHARLES B. HITCHCOCK

During our stay in Puerto Ayacucho afternoon showers were seen in the hills to the east. Some cloud development was noticeable there, though the lowland area remained clear. On the reconnaissance flight over the mountains cumulus clouds were forming rapidly at about 11 o'clock in the morning. On the afternoon of our departure from Puerto Ayacucho, February 3, a heavy rainstorm occurred at Sanariapo. For the next 34 days, until we reached the Río Ventuari on the return trip on March 9, no rain fell except a few drops, literally speaking, one evening in the Caño Parucito.

On so short a trip it is possible to obtain a general picture of the year-round climate

only by questioning local inhabitants.[27] Except where amplified by observations made in the field, the following description is based on such conversations.

In the savanna country of the Río Manapiare and the Caño Parucito the dry season begins early in December, and from that time until mid-April there is little rain. Apparently the conditions we experienced in February and March were normal, though on our return to Puerto Ayacucho in early March both the Ventuari and the Orinoco were said to be at a somewhat lower stage than usual. By the end of April the rainy season is in full force, and for several months the rivers rise rapidly. In August they begin to recede; rain is less frequent, falling generally about midday and in the late afternoon; by December it has virtually ceased. Presumably the period of dry weather is related largely to the southward migration of the subtropical high-pressure belt.

Local topography may well play a part in increasing the length and intensity of the dry period. The prevailing winds during our stay came almost without exception from the northeast quadrant. To reach the savanna lowlands, these winds must rise over an extensive region of broken, forest-covered mountains, and some rain shadow effect is expectable. Strong convectional currents over the savanna during the dry season (*verano*) must further stimulate the drying out of the local air.

A typical day in the Parucito lowlands in February or March may be described as follows:[28] The 6:00 a. m. temperature is from 72° to 75° F., and the relative humidity usually from 81 to 87 per cent, though it is sometimes as low as 69 per cent or as high as 93 per cent. The early morning is clear, with gentle winds from the northeast, which increase in velocity during the morning. By midmorning there are scattered cumulus clouds over the region, with intermittent development of cloud along the north summit of Yaví and some cloud banner on the peak of Cerro Campanero, 25 miles to the north at the headwaters of the Parucito. By noon the temperature has risen to 85°–90° F. and the relative humidity has dropped to about 56 or 58 per cent. It is not uncommon to have some development of alto-cumulus and cirrus clouds during the day. In the late afternoon the wind dies down; the 6:00 p. m. temperature is between 82° and 85° F.; but the humidity has risen to 70–75 per cent. The lowest relative humidity recorded at 6:00 p. m. was 52 per cent. During the afternoon, and particularly at sundown, there is some cloud formation on the higher mountains at about 6000 to 6500 feet. The night is generally cloudless, with little apparent wind movement; several times we saw lightning in the distant mountains to the north, and also far to the south along the Ventuari. Toward the end of our stay skies were partly overcast in the early morning but cleared gradually by 10 or 11 o'clock.

During the two days spent at the lowest camp on Yaví (1400 feet) the temperatures were not noticeably lower than in the lowlands, but the relative humidity was less, not more than 50 per cent in the early evening and 63 to 67 per cent at 6:00 a. m. At the 4500-foot camp, where subtropical plants were predominant, morning temperatures were considerably lower. In seven days of observation the 6:00 a. m. temperature remained between

[27] Since 1942, records of barometric pressure, temperature, rainfall, and number of days with rain have been kept at the Salesian Mission in Puerto Ayacucho. Evaporation observations were added in July, 1944, and wind-direction data in August, 1945. Because of the short period covered by these records and the fact that they refer only to the margin of the region concerned, the data have not been used here.

[28] Temperature and humidity records were kept daily. The figures given represent extremes, since the record is too short to permit any significance in averages.

60° and 63° F., and the 10° decrease from the lowland temperature made acceptable a sleeping bag hung within a hammock, a convenient arrangement devised by Mr. Phelps. Midday temperatures differed little from those of the lowlands, but again at sundown there was a greater drop; the readings showed 67° to 69°. Relative humidity, averaging 80 per cent at dawn, fell to less than 50 per cent at noon, and at dusk was never more than 67 per cent. It was "comfortable" weather.

At the third camp, at 5725 feet in the large east-west valley dividing the northern and southern summit areas of Yaví, the two-day record showed 6:00 a. m. temperatures of 54° and 57° F. and a sundown temperature of 61° F. As had been expected, there was more cloud formation, and a local easterly down-valley breeze tended to develop in the evening. At the summit, where two days were spent, 6:00 a.m. temperatures were 52° and 55°; at midday there was a rise to the low 70's, and at sundown a drop to 60°. Relative humidity was about the same as in the lowlands. Scattered clouds formed overhead during the daytime and on both days developed locally over the northeastern and northern cliffs at about 5:00 p. m. but dissipated soon after they had moved southward over the summit. Not until 6:30, after the sun had gone down, did the clouds reach the center of the summit area. On both nights sundown brought a heavy dew. The coolness of the summit area, invigorating to us, had the opposite effect on the lowland Indians. One of them, an intelligent individual, commented that it made him lose his appetite.

The following brief description of weather conditions observed during a two-week collecting trip on Cerro Sipapo (Paraque) is taken from the field notes of Mr. Phelps, dated February 3, 1946. During this period various camps between 900 meters and 1800 meters (the western summit) were occupied: "Clear in the morning; occasional short rains in the afternoon and during the night—always accompanied by strong, gusty winds and mists which dissipate after about one hour. Thunder on stormy nights. The wind always appears to come from the east. There has been only one heavy downpour (*aguacero*)—the kind that penetrates the forest cover and thoroughly moistens the ground—and this lasted at the most one-half hour."

INDIANS OF SOUTHEASTERN COLOMBIA

PAUL H. ALLEN

ONE of the unexpected by-products of the search for new rubber areas occasioned by the critical wartime need was the opening to relatively easy access of South American forest areas having Indian populations almost untouched by modern civilization. This is particularly true of the Río Vaupés region of southeastern Colombia. Until the rubber program introduced air transport, contact with the outside world was limited almost entirely to the balata workers who occasionally made the river journey to Manaus—a jungle odyssey of 60 days' paddle down the cataract-broken stream. The alternative route was through the forests and across the trackless llanos to Villavicencio, at the foot of the eastern Andes. Today, thanks to the now highly developed Colombian air transport service, one may be in Mitú, the Colombian government headquarters in the Vaupés Comisaría, within three hours' flying time from Bogotá. However, short river trips away from Mitú find Indian life continuing in the primitive pattern.

The Landscape

The Vaupés, a western tributary of the Rio Negro, is a great meandering river flowing through almost unbroken rain forest. The long reaches of quiet water are broken by boulder-filled rapids and falls, which bear rhythmic, many-syllabled names in Tupí-Guaraní, the *Lingoa Geral.*

From the air the region is seen to be flat or slightly undulating, with occasional islandlike, bare-topped, conical granite hills, long, rounded ridges, and isolated broken mesas of overlying sandstone trending northeast-southwest. In the late afternoon light the white escarpments of one of the most typical of these, the Cerro de la Pintura, resemble the skyscrapers of a great modern city. The mesas are the home of the famous cock of the rock (*Rupicola*), whose curious mating dance was described by early naturalists. The young male birds develop a brilliant orange plumage, and they are often taken by the Indians and kept for sale to passing travelers.

A climax rain forest covers nearly all the area south of the Río Guaviare. Usually there are three or four huge trees to the acre, averaging 90 feet in height, surrounded by a wealth of palms and smaller trees whose full development awaits a break in the canopy. The sandy uplands and mesa tops have rather extensive patches of low, scrubby trees and bushes, grading into open savanna. Meandering tributary streams are often flanked by oxbow lakes

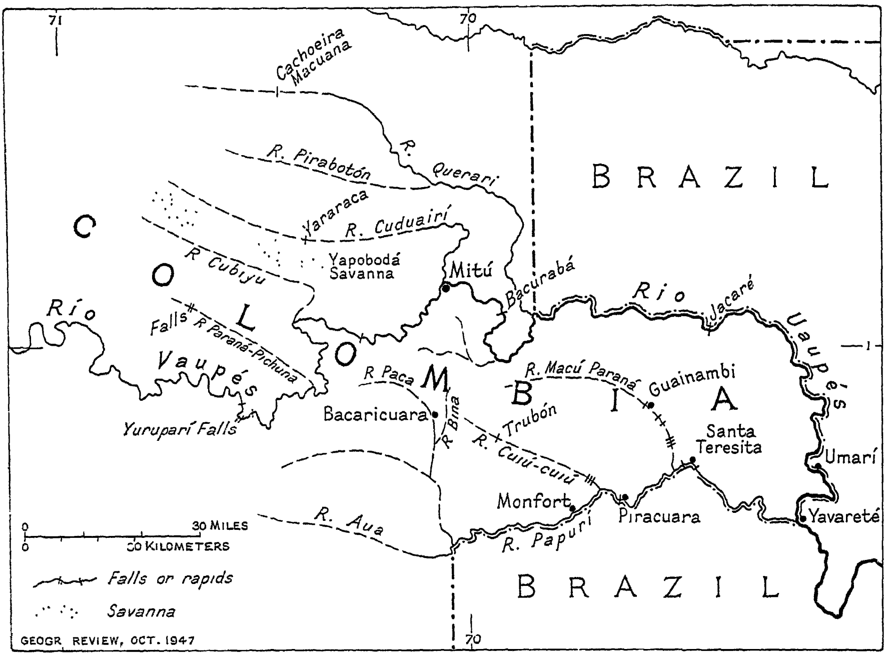

FIG. 1—The Río Vaupés region.

and low natural levees, behind which the poorly drained marginal lands are flooded to a depth of three to five feet during the entire rainy season. Here are found many peculiar species of trees, including some kinds of rubber (*Hevea*) and *massaranduba* (*Mimusops* sp., a source of chicle), the roots of which can withstand long periods of submergence. Here also is to be found that rarest of botanical treasures, a blue orchid (*Acacallis cyanea*), until recently lost to the scientific world since Richard Spruce saw it in the 1860's.

Scattered throughout the rain forest are areas of sandy soil, supporting the curious low, open woodland called *caatinga* by the local Brazilians. The trees average less than 20 feet in height, and most of them have rounded leathery leaves. Primitive ferns and mosses form low mounds about the bases of the trees, and epiphytic orchids and bromeliads abound. Other areas have small residual ponds, and dense groves of *caraná* palms (*Mauritia carana*), somewhat resembling the palmettos of our own southern states, make them conspicuous from the air.

Many of the huge thatched communal houses, *malocas,* are on low ridges near falls or rapids, but others, far from any major stream, can be located from the air only by means of the rounded patches where the forest has been cleared for planting.

FIG. 2—A grove of Mauretia palms in the vicinity of the Ariari, tributary of the Río Guaviare.

TRIBES AND DIALECTS

For some inexplicable reason, the area from the falls of Yuruparí eastward to the junction of the Vaupés with the Río Papurí is malaria-free, and it is here that the majority of the Indian population lives. No accurate census has ever been taken, but it is estimated that there are now about 8500 Indians in this section. The white man's diseases, against which the Indians have little resistance, have evidently decimated what must once have been a much larger population. During our rubber working season of 1943–1944 a severe epidemic of measles swept the camps, leaving more than 50 known dead. Old settlers remember the smallpox epidemic of 1917–1918, when whole malocas were wiped out. All personnel were vaccinated during the 1944–1945 season, and it is hoped that others can be protected in some way.

Tribes are of varying social status; in fact, away from the mission villages almost a caste system prevails. Indian society ranges from large, powerful groups such as Cubeos, Tucanos, Tarianas, Piratapuyos, and Desanas downward through Cirianos, Yurutises, Carapanás, Tatuyos, Barás, and Carijonas to the lowest rung of the social ladder, the unrelated, nomadic Macuses. These last are generally despised; *Macú* is one of the most insulting terms that can be applied to an Indian of this region.

Although nearly all the tribes supposedly belong to the general Tucanoan linguistic stock, a bewildering number of dialects are spoken. Tribes at any distance from one another have distinctive vocabularies, but most of the older men speak some Geral, Cubeo, or Tucano, all of which are in fairly wide use. Many of the men who have worked in the rubber camps now speak enough Spanish to be understood, though it is difficult to obtain specific information, since all the dialects lack words to express abstract ideas. For example, reports were received in Mitú of great stands of rubber trees in the Río Papurí drainage area, but investigation revealed that to the Tucanos any number over five is *fe*, or "a great many," and that although they have specific names for many kinds of trees, they have no word for rubber, *di*, meaning "milk," or applied to plants having milky latex, being the nearest. It was a constant source of surprise that even Indians who had had fairly frequent contact with civilization and who spoke a good deal of Spanish could not count above 20.

Although each dialect has its own words for local place names and the names of animals, birds, plants, and fish, they are best known in Geral. For example, *mitú* is Geral for a certain species of large bird for which the word in Cubeo is *anunquimbo*.

The Malocas

Away from the mission villages, residence is in malocas, some of which measure as much as 70 by 75 feet. They are thatched with fronds of such palm species as *caraná* (*Mauritia carana*), *ubí* (*Manicaria atricha*), *ubí mirí* (*Manicaria martiana*), or *poktamwi* (*Lepidocaryum allenii*). Considerable care is exercised in the thatching. The small fronds of the ubi miri and poktamwi are plaited by their stems onto laths of split palm trunk, to form giant elongated shingles. These are then lashed one above the other onto the framework. The supporting posts, usually of termite-resistant *acaricuara* wood (*Centostigma* sp.?), are placed so as to leave an open space in the center for ceremonial dances. As many as 40 individuals may live in a maloca, generally brothers with their wives and families. Each family group is allotted one or more of the lateral spaces between the supporting posts, averaging 8 by 12 feet, for cooking fires and for hammocks.

The malocas are lighted only from the front and rear doorways. The doors are mats of palm fronds strengthened by stakes and hinged at the top; they are propped up during the day. The darkness of the interior is a decided advantage, since it affords protection from the myriads of tiny sand flies that would otherwise, in some areas at least, make life almost unbearable.

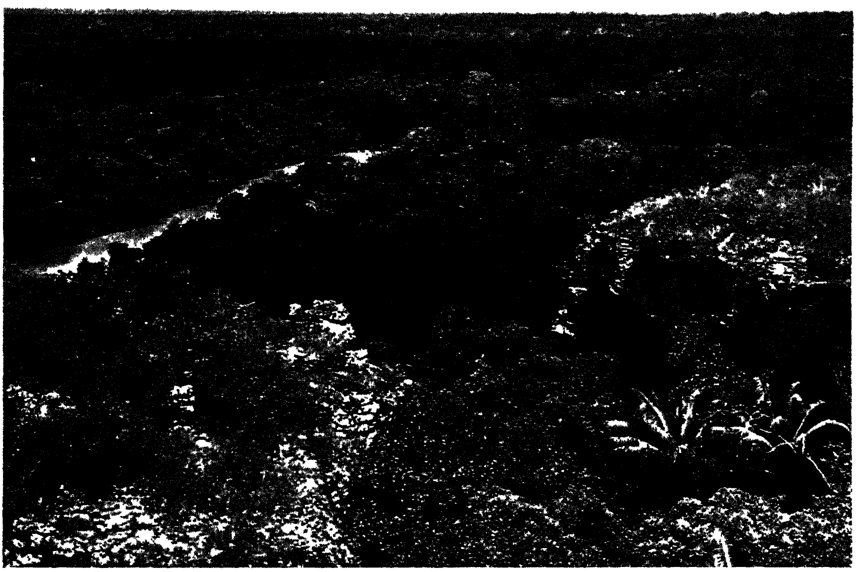

Fig. 3—Cerro de la Pintura on the Upper Río Inírida (about 2°10′ N., 71°25′ W.).
Fig. 4—Forests of the Upper Inírida, as seen from the Cerro de la Pintura.

FIG. 5—Kubeo boy at Yararaca, Upper Cuduairí, demonstrating the use of the blowgun.

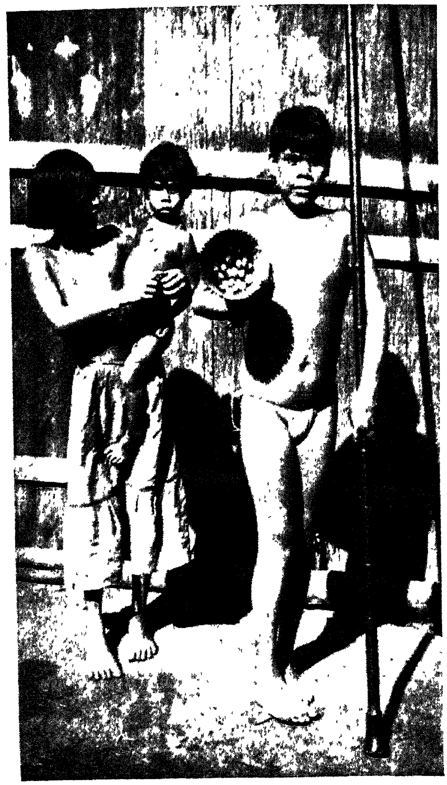

FIG. 6—A close-up of the same boy with blowgun and quiver for the darts.

FIG. 7—Matched pairs of Yuruparí horns in use.

Fig. 8—A young Kubeo couple painted for a ceremonial dance.

Fig. 9—Kubeo man being painted with *urucú.*

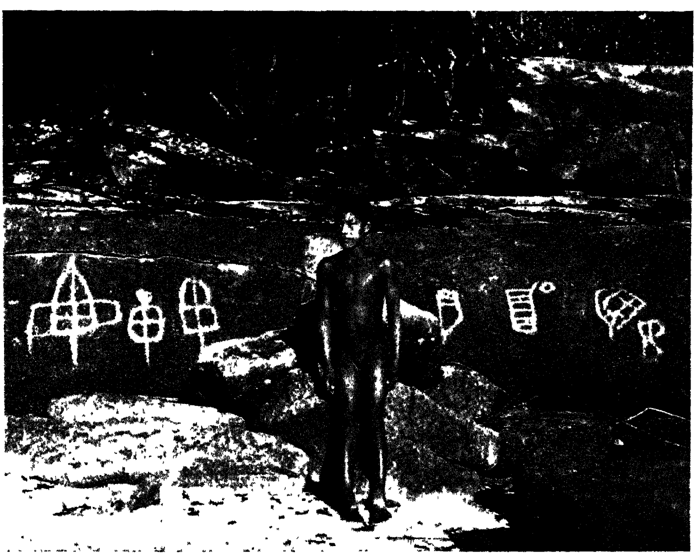

Fig. 10—Crude figures pecked in granite. Such figures are common near rapids in the Papurí, Paca, Macú Paraná, and Cuduairí.

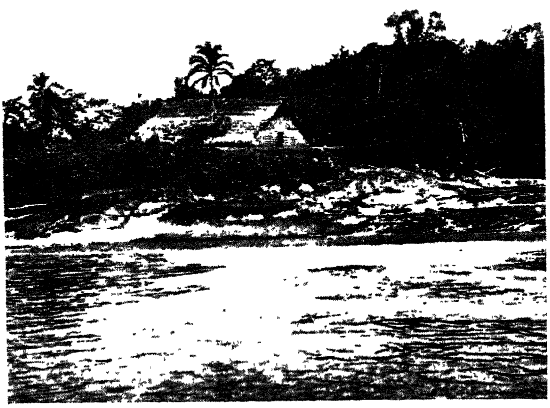

FIG. 11—Typical Vaupés Indian communal house.

Many hammocks are hung about, made either of the traditional palm-fiber nets or of cotton cloth obtained from Brazilian or Colombian traders. The cotton hammocks are warmer and are much preferred. Where the old-style nets are still used, it is customary to keep a small fire burning to one side of the net through the night. Several cooking fires are usually going; the black clay pots are supported on three hollow cylinders of baked clay.

Furnishings consist principally of low wooden stools; implements and utensils include one or two huge hollowed tree trunks for the brewing of *cachirí* for ceremonial occasions, blowguns, quivers of poisoned darts, bows, and long fishing arrows, fariña presses, huge, shallow clay pans with built-in ovens for baking cassava and drying fariña, beautiful circular woven trays (*balayas*), grating boards for making cassava, and mortars for the preparation of coca. The weaving of baskets from split maranta canes has been developed into a fine art by the men, and many beautiful and complicated colored designs are seen.

A settlement has as standard equipment objects manufactured by widely scattered tribes. For example, the common wooden stools of the region are made only by Tucanos. Certain basket and balaya types are restricted to Piratapuyos, others to Macuses or Banívas. Blowguns and the cleverly constructed baskets for the darts as well as the deadly curare are all made nowadays by Macuses, though other tribes evidently once had the art. Only Cubeos make the painted bark death masks, but they are often seen in the malocas of neighboring Guananos. The cassava graters used everywhere are manufactured by Banívas of the Río Isana region and are obtained by barter by all other tribes. Only after long acquaintance is it safe to assume that articles found in any given locality were made by the residents.

In the evening a standard task of the women is to prepare coca (from *Erythroxylon coca,* the source of medicinal cocaine). The freshly gathered green leaves of the shrub are dried rapidly so that they retain their color and are mixed with the ashes of *Cecropia* leaves; the whole is reduced by

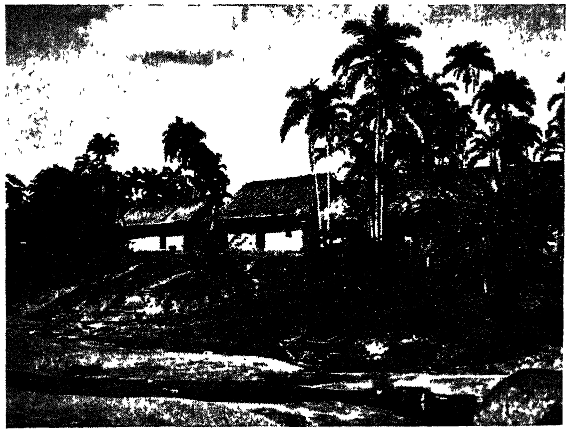

FIG. 12—Brazilian Mission village of Umarí, Rio Uaupes.

repeated siftings and poundings in the wooden mortars to a dust-fine, olive-green powder. A heaping tablespoonful is held in the cheek, and is slowly absorbed while the men smoke tobacco and talk over the day's happenings. Among my clearest memories of the many nights spent among the Cubeos is the muffled, rapid vibration of the coca pestle and the oft-repeated "Kay-va-ma-kay, Kay-va-ma-kay, Kay-va-tu-di, pa-ku-ma" (So it was, so it was, my friend). Coca in this form does not seem to be seriously habit-forming; the effects are merely a slight stimulation and a numbness of the tongue.

AGRICULTURE AND FOOD GATHERING

Agriculture is primitive. Patches of forest are cleared and burned, and the spaces between the charred logs are planted by the women to bitter yucca (*Manihot*), lulus (*Solanum globiferum*?), plantains, pineapples, peppers (*Capsicum*), yams (*Dioscorea*) of a curious deep-purple variety, coca, and, rarely, corn. New clearings are made every few years, so that they are often at some distance from the maloca. Groves of fruit trees surround many of the malocas—pupuña palms (*Guilielma gasipaes*), *guamos* (*Inga spuria*), Annonas, caimarones (*Pourouma cecropiaefolia*), Lucumas, breadfruit (*Artocarpus*), cashews (*Anacardium*), and others. Wild cane (*Gynerium*), common on most riverbanks in tropical America, is found here only in small cultivated patches; the straight, light, flowering stems are used for fishing arrows. Agricultural products are supplemented by many forest fruits, such as the well-liked *umari*, or seeds of various trees, including some rubber-producing species. The seeds are reduced to meal, and the poisonous principle leached out. Hunting also adds to the larder; one of the main reasons for engaging in rubber work is to obtain a trade gun to replace the relatively inefficient blowgun and poisoned darts. Heavier poisoned arrows are (or were) used with a bow for larger game, which, if the older inhabitants are to be believed, included human beings until some thirty years ago, for cannibal feasts often accompanied tribal dances.

FIG. 13—Passing a canoe through the Bacurabá cachoeiro.

Fish are abundant, and many methods are used for taking them. Traps are set in fast water on the margins of falls, and lattice screens with a basket trap are often seen blocking the mouths of small tributary streams. During the rains, the mouth of a small *igarapé* is blocked with a lattice screen at night, after the fish have entered to feed. Rings of stakes are planted in shallow water up stream, and a quantity of a barbasco, in this case the bristly, sea-urchin-like, toxic fruit of an unknown leguminous tree, is macerated and placed within the rings. The poison, carried by the current, drives the fish downstream; when they are crowded near the lattice fence, more crushed barbasco is thrown into the water there, and the stupefied fish are scooped from the milky water with nets or balayas. During the dry season, when the Vaupés is low, pools between the exposed granite rocks are blocked off with broad leaves, and sections of a cultivated woody vine (*Lonchocarpus*), as large as a woman's forearm, are beaten with mallets and thrown into the water, to poison the fish until they can be readily caught. Large catches, obtained in this way, are apportioned among families in the maloca. Some of the fish are smoked on racks of split cane over slow fires and preserved for future use.

Other forest products give variety to the diet. During my stay in the Río Papurí region, every able-bodied man left for the Río Paca in August to gather *tapurú*, colonial caterpillars of two species, one black, one red, that feed on the leaves of an unidentified euphorbiaceous tree called in Tucano *wak-puh*. The caterpillars are dried on split-cane mats over slow fires, protected from the rain by overhanging palm fronds, and are carefully stored in leaf-lined baskets. A family often collects as much as six bushels in a week. Boiled fresh and skinned, the caterpillars taste much like good shrimp, but when dried they acquire a decidedly sawdust flavor. Beetle larvae and some species of ants, particularly the leafcutters, are also collected and are regarded as great delicacies.

Although fish and various forest products form the "caviar" of the

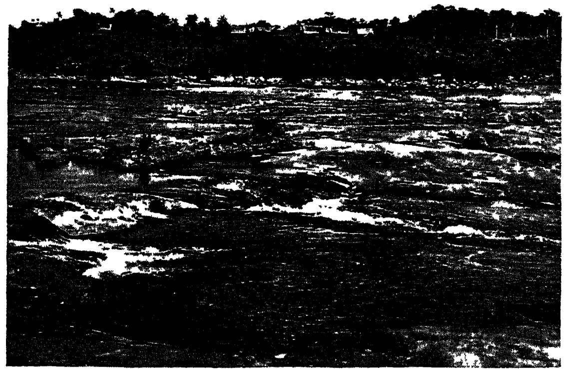

FIG. 14—Brazilian Mission village of Yavareté, from the Papurí.

Indian diet, the everyday staple is cassava, made from the roots of the bitter yucca. These poisonous roots are soaked in water for several days, peeled, and grated by hand on shallow boards set with tiny quartz crystals cemented in geometric patterns with balata gum. The wet mash is fed into an ingenious contrivance, a cylindrical receptacle woven of split maranta canes, capable of expansion to several times its diameter but contracting to a very slender tube under tension and resembling in principle the Chinese finger traps or the metal sleeves used in our war plants for lifting shells. The tube filled with wet mash is hung to a rafter pole, a long rod inserted in the lower loop, and pressure applied, usually by a woman sitting on the end of the pole. The poisonous juice is squeezed out, and the mealy residue is baked on one of the huge oven pans into a large circular cake averaging two feet in diameter and half an inch in thickness. It is prepared daily and eaten fresh. The grated meal may, however, be allowed to ferment for a day or two to give it a pleasant, slightly acid flavor, after which it is placed in the heated clay pan and constantly stirred, to form fariña when dried. This is usually stored in woven baskets of about two pecks' capacity, carefully lined with special leaves that mature the flavor of the product. These *paneros* of fariña are a standard article of commerce and form the basic provisions for all voyages, or for rubber and balata operations.

SOCIAL AND RELIGIOUS OBSERVANCES

The tribes are strictly exogamous. Brides are traditionally stolen in the night, though there is some evidence that in recent years there has often been a previous purchase agreement with the parents. The couvade is observed, the father being confined to his hammock for some time after the birth of the child. If a baby is malformed, it is buried at once; if twins are born, one of them, preferably a girl, is buried. Nevertheless, a strong affection is shown for children, and although they are seldom punished, they are remarkably well behaved. This is by no means to be taken as an indication

that these youngsters are not entirely normal, and, contrary to popular supposition, Indian babies do cry.

Caciques, or *Tuchaguas,* exercise a mild authority. They are called *capitanes* by the Colombian authorities, who issue them formal commissions, signed by the Protector of the Indians and the Comisario.

The religion is a primitive, little-understood belief in forest and water spirits, most of which are believed to be harmful and which must be variously

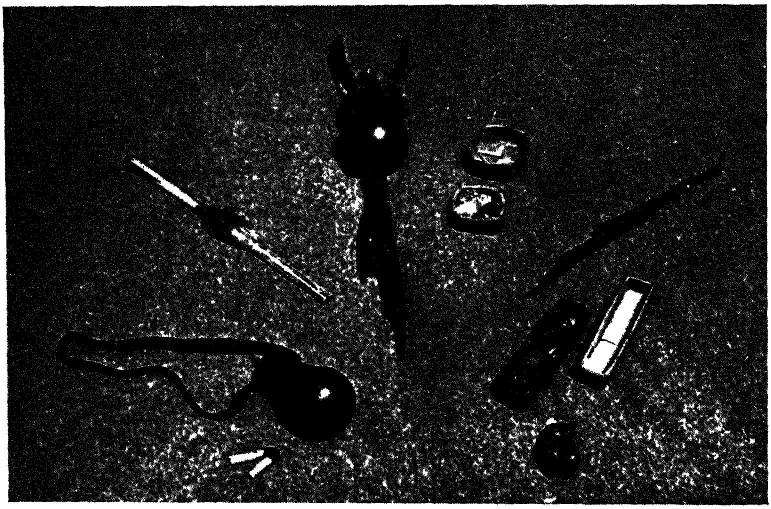

Fig. 15—Payé equipment from the Vaupés. From left to right: gourd for carrying tobacco snuff and Y-shaped bone instrument used to blow the snuff into the nostrils; bone tube decorated with a ruff of toucan feathers, used to blow pwodered *paricá*; Payé rattle; boxes made from leaf strips of the *miriti* palm (Mauretia) containing quartz crystals and bundle of *mirá-piranga* sticks used for treating rheumatism; large quartz crystal.

propitiated. There is apparently a belief in some sort of after life. The Cubeos have a tradition that the souls of their dead reside in or near a series of sandstone caverns on one of the open savanna areas between the headwaters of the Río Cuduairí and the Río Cubiyu, known in Cubeo as the *Yapobodá.* Some tribes apparently believe that the souls of the dead reside in animals, particularly deer.

Religion and medicine center in the cult of *Payé* men, who supposedly have the power to call down lightning, change the weather, transform themselves into jaguars, shoot magic stones that kill or sicken, and cure disease. Power over lightning is believed to be contained in large perfect quartz crystals, an indispensable feature of every Payé kit. The crystals are kept in special palm-leaf boxes. Of equal importance is the medicine rattle, made of a small, round gourd, painted red with *urucú* (*Bixa orellana*), and having

a handle of a heavy, dark-red wood called *mirá-piranga* (*Brosimum* sp.). These rattles contain tiny quartz crystals and sometimes have a larger crystal cemented to the handle, the whole topped with a gay ruff of toucan feathers. It is with the rattle that changes in the weather are effected, and the quartz crystals may be projected by the Payé to any distance to kill or injure an enemy. Sickness, injury, and death are never attributed to natural causes, but invariably to some human agent, who must be sought out by the aid of a Payé. The powdered seeds of *paricá* (*Piptadenia peregrina*) are blown forcefully through a bone tube into the nostrils of the Payé, producing a sort of ecstasy, during which he determines the guilty party.

Treatment of disease is also in the Payé's field and is accomplished by pure "magic" without the aid of any vulgar pharmacopoeia. The patient is seated on a log or stone. The practitioner stands behind him, dips up a calabash of water, takes a liberal mouthful, blows it forcefully over the patient's back, and follows it with the remaining contents of the gourd. This treatment is repeated to the quantity of about 25 gallons. The Payé then presses the crown of the patient's head, the back, chest, and sides, blows up and down the spine, and eventually extracts the source of the ailment in a crystal previously concealed in his mouth. Rheumatism, known as *palitos* (little sticks), is extracted in small bits of mirá-piranga wood thoughtfully placed by the Payé in the curative water beforehand. A frequent result of this treatment, particularly when given for measles, smallpox, or a common cold, is an understandable complication of bronchial pneumonia, which often ends in the death of the patient.

Ceremonial Dances

Ceremonial dances are of several types and are invariably accompanied by the drinking of great quantities of cachirí, a beverage prepared from almost anything capable of being fermented but most frequently from toasted cassava cakes broken up and steeped in water sweetened with cane juice. In February and March the farinaceous fruits of the pupuña palm are used; they are boiled, grated, and fermented into a thick orange brew. The taste is acidulous and rather pleasant. The alcoholic content is probably about that of beer, but the drink is provided in such quantity that all and sundry manage to get drunk on it.

One of the most familiar of the dances is the *dabucurí*, to which the participants bring gifts of large amounts of jungle fruits. Haunting music is played on panpipes and on long paired flutes, the carefully matched tones of which are reminiscent of clarinets. Among the Cubeos there still persists

an interesting custom of masked dances performed some time after the death of a tribesman. Formerly the individual was buried in the floor of the maloca and the grave was watered down (this is still in practice); after six months or more the body was disinterred and the bones reduced to charcoal, pulverized, and mixed with the cachirí for drinking. The masks are manufactured from natural bark cloth, variously painted, and cover the face and the entire body. On the morning after the ceremony the costumes are set on stakes fronting the maloca and burned.

Important dances are accompanied by the use of much paint. The men use *carayurú,* (a red pigment prepared from the leaves of *Bignonia chica*), in bands of geometric design applied to the arms and legs with the aid of engraved wooden rollers. Another red coloring, obtained from *urucú,* is frequently daubed on at random. Women also paint, but usually in deep purple; the dye is obtained from the leaves of an unidentified Rubiaceous shrub cultivated for the purpose. Feather ornaments play a considerable part in all ceremonies, and most older men have palm-leaf boxes containing more or less complete regalia for several individuals. These ceremonial pieces are frequently in matched pairs and are highly prized; purchase is difficult. Most of the ceremonial material used today among the Cubeos and Guananos on the main river has been obtained by barter from neighboring Desanas living along the Abio and the Macú Paraná.

The Yuruparí Ceremonial

Most famous of all the dances is the *yuruparí,* a ceremony performed only by men. The following notes from my diary illustrate typical uses of ceremonial objects. The occasion was a rare yuruparí and dabucurí dance seen at Bacurabá on March 24, 1945.

A deep booming of drums from within the maloca heralded the appearance of the mystic yuruparí horns. With only very slight urging from one of the older men, all females from babes in arms to withered, toothless hags betook themselves to the fringing forest, to hear only from afar the deep, mysterious notes of the trumpets, sight of which is believed to spell certain death for any woman. White settlers in the region declare that the Payés and older men are not above aiding the workings of the mystery by the judicious administration of poison to any overcurious female.

Four pairs of horns had been taken from places of concealment, and the players now ranged themselves in a rough semicircle, producing the first deep, lugubrious notes. The horns were in matched pairs, made from sections of palm trunk about four inches in diameter. Two of the pairs were simple cylindrical sections about three and five feet long respectively, with bits of green leaf bound above and below the sound openings, which had been carefully adjusted to produce identical tones. The other two pairs were similar but much shorter

sections and were fitted with elaborate flaring trumpets of spirally wound strips of bark strengthened with narrow lateral wooden strips. These gave forth exceedingly deep, booming notes. Evidently considerable lung power was needed to blow them as indicated by the inflated cheeks and rigid throats of the players.

Many of the older men had meanwhile opened their *tangatára* boxes of ceremonial feathers and were selecting with great care brilliant feather ruffs, which were bound to the mid-section of the longer horns, one pair being fitted with long scarlet *guacamayo* tail feathers, the companion set with dense ruffs of bright yellow *Oropéndola* plumes. Four

FIG. 16

FIG. 17

FIG. 16—Bark-cloth mask worn during special ceremonies following the death of a Kubeo tribesman.

FIG. 17—Young man holding a ceremonial whip and showing marks of lashes received during his initiation during the Yuruparí ceremony.

oldsters, with perfect rhythm and dramatic timing, paraded through the maloca, blowing the newly decorated horns, advancing and retreating with short dancing steps. At intervals a couple danced out of the door, their horns raised high, and returned after a brief turn, the expanding and contracting feather ruffs producing a beautiful burst of translucent color against the stronger light. Younger men were beginning the first of the savage whippings, and the master of ceremonies appeared with the red, curiously shaped clay jar containing the powerful narcotic drink called *caapí* (prepared from the macerated stems of *Banisteria caapi*). The thick, brown, bitter liquid was served in pairs of tiny round gourds; many drinkers promptly vomited. White settlers who had tried the brew agree in their descriptions of preliminary visions of beautiful colors and scenes, followed by a sense of mortal terror as they felt themselves enveloped in flames or being devoured by jaguars.

Whipping proceeded by pairs. The first lashes were applied to the legs and ankles, the whip flung far back in a deliberately calculated dramatic gesture; the blows resounded like pistol shots. Places were immediately exchanged. Soon the whips were being freely applied,

and all the younger men were laced with bloody welts on all parts of the body. Tiny lads not more than six or seven years old would catch up the abandoned whips, merrily imitating their elders. Gradually the volume of sound diminished, until only two lone performers remained, enchanted with their art, bowing, advancing, and retreating, with great delicacy and grace, in the center of the maloca. About a dozen of the older men were outfitting themselves with their finest diadems of resplendent guacamayo feathers, tall, feathery egret plumes, oval pieces of the russet skin of the howler monkey, armadillo-hide disks, prized loops of monkey-hair cord, precious quartzite cylinders, and jaguar-tooth belts. Bedecked with these triumphs of savage art, the men formed a swaying, dancing semicircle, each with his right hand resting on his neighbor's shoulder, all shifting and stamping in slow unison. Leading the group was the ancient Payé, blowing tobacco smoke in benediction on his companions from the huge cigar in its engraved ceremonial fork, while his long, polished rattle-lance vibrated constantly. The familiar, dignified cachirí ceremonial chant was intoned by the group; their deep voices rose and fell, mingling with the mysterious booming tones of the yuruparí horns.

On my departure my old friend Marcelino of Trubón cachoeira remembered enough Spanish to wish me a pleasant journey. He asked an evidently often pondered question, as to whether my land might be somewhere in the sky, since he had invariably seen me arrive by plane and return in the same way.

THE ECONOMY OF THE FREE TERRITORY OF TRIESTE

LEONARD UNGER

THE Italian Peace Treaty provides for the establishment of the Free Territory of Trieste, independent of Italy and Yugoslavia alike, its integrity and independence guaranteed by the Security Council of the United Nations.[1] The treaty defines the boundaries of the Free Territory and sets forth principles for its government and the operation of its Free Port and for certain aspects of its relations with other countries and provides guarantees of the continued availability of certain essential supplies and facilities. The economic clauses include the following:

The Permanent Statute of the Free Territory (Annex VI to the treaty) provides for an independent currency. It regulates aviation, railway regimes, and the registration of vessels, and it guarantees that goods going to and from the Free Port shall be accorded "freedom of transit" by the Free Territory and by any state whose territory is traversed.

The Instrument for the Free Port of Trieste (Annex VIII) establishes the Free Port, free of customs, "in order to ensure that the port and transit facilities of Trieste will be available for use on equal terms by all international trade and by Yugoslavia, Italy and the States of Central Europe." The Instrument binds the Free Territory and the signatory countries through whose territories the Free Port's traffic passes to facilitate the movement of this traffic and not to apply any discriminatory measures against it. These countries are also forbidden to take any measures "regarding regulations or rates which would artificially divert traffic from the Free Port for the benefit of other seaports."

The Free Port Instrument also sets up an International Commission to oversee the operation of the port and transit facilities. The membership, other than the Four Powers and the Free Territory, reflects the extent of the hinterland: Yugoslavia, Italy, Czechoslovakia, Poland, Switzerland, Austria, and Hungary.

The treaty further guarantees (Annex IX) that Yugoslavia will maintain the supply of water to northwestern Istria within the Free Territory from springs within Yugoslav territory. It provides for the continuation of the

[1] Treaties of Peace with Italy, Bulgaria, Hungary, Roumania and Finland (English Versions), (*U. S. Dept. of State Publ. 2743 European Ser. 21*), 1947. An accompanying case of maps constitutes Annex I of the Italian Peace Treaty; Annex II gives a detailed description of certain sections of the Franco-Italian frontier.

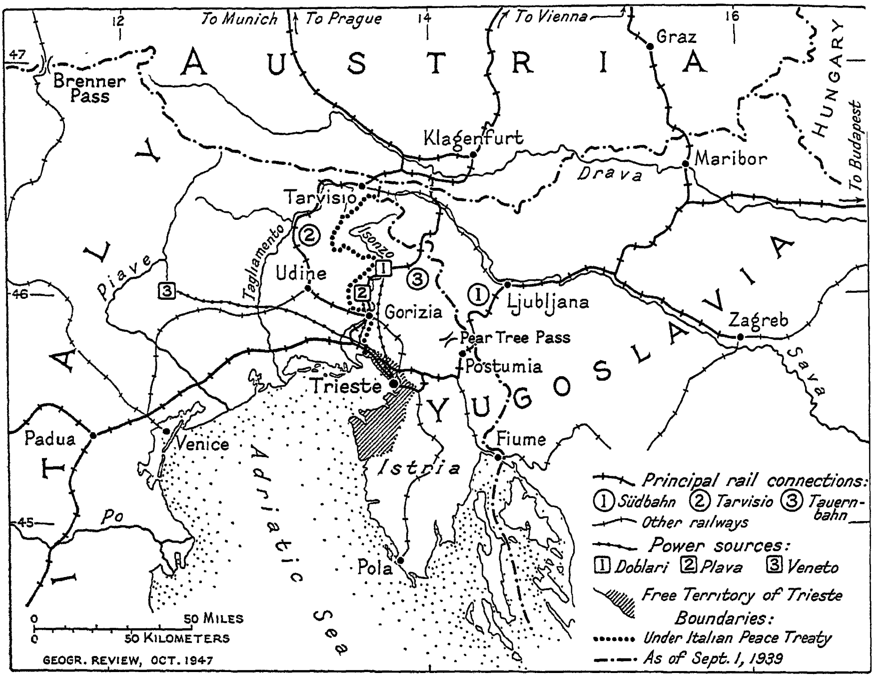

FIG. 1—Map showing railway connections and power sources (lines and stations) of the Trieste region.

existing system that supplies electric power to the Free Territory, and also to the rest of Venezia Giulia. It stipulates that measures shall be taken to facilitate local trade between the Free Territory and Italy and the Free Territory and Yugoslavia. Annex X treats of financial and property matters.

The General Situation

Trieste lies at the head of the deep-penetrating Adriatic where it reaches almost to the borders of Danubian Europe. Through its port has moved, in modern times, the larger part of the goods that landlocked Austria, Czechoslovakia, and Hungary have sent abroad or have imported from overseas; and it is also the natural outlet for the immediately neighboring regions in Italy and Yugoslavia (Fig. 1).

The comparative railroad distances of Table I point the natural advantages for Danubian traffic of any port at the head of the Adriatic. It has been Trieste, however, rather than Venice or Fiume, that in modern times has reaped the principal benefit of this position. Trieste is closer to the Postumia Gate than the other two ports and is connected with it by a relatively easy route. This pass (2020 feet), lying between the Julian Alps to the north and the Dinaric Alps to the south, provides the lowest and perhaps the

easiest route between Mediterranean and Danubian Europe, "between the Bosporus and the Rhone Valley breach."[2] The situation was equally important in ancient times. The Postumia Gate was well known and used even as far back as the Argonauts.

Trieste is thus situated in a transitional region between Mediterranean and Danubian environments. Climate, vegetation, language, culture, and many related factors, although predominantly influenced by Mediterranean

TABLE I—DISTANCE BY RAIL IN KILOMETERS

	Trieste	Fiume	Venice	Hamburg
Vienna	555	553	635	987
Budapest	607	605	...	1328
Prague	828	826	881	640
Ljubljana	129	127	...	...
Munich	552	...	...	739
Belgrade	677	...	...	1802

and Italian elements, partake also of many Danubian and Slavic characteristics. This transitional situation endows the city with a unique interest and variety and provides the contrasting environment so stimulating to trade. But it has also heightened the rivalry to possess Trieste, which has appeared from time to time in history, by linking the region with its neighbors in several directions.

THE PHYSICAL SETTING

The city of Trieste lies on the northernmost extension of a belt of sandstone hills that slopes steeply from the Karst Plateau (about 1300 feet) down to the sea (Fig. 2). The oldest part of the city climbs a small hill overlooking the harbor; the newer parts stretch out on flat, reclaimed tidal marshland and on neighboring hills and slopes leading up to the plateau.

The Karst Plateau, made up of very thick layers of highly soluble, porous limestone, has almost no surface drainage; most of the precipitation runs off in underground streams fed through sinkholes, *dolini*. The belt of sandstone hills which underlies the city of Trieste and extends south and west to form the northern Istrian coast line is a highly dissected region of mature relief with level land only where deltas and tidal flats have been built out at the edge of the water. In its heart are some very isolated communities. Dominating the Bay of Pirano and the Dragogna Valley on the southwest is the escarpment of a lower karstic plateau (300 to 400 feet) that fills in the

[2] E. C. Semple: The Barrier Boundary of the Mediterranean Basin and Its Northern Breaches as Factors in History, *Annals Assn. of Amer. Geogrs.*, Vol. 5, 1915, pp. 27–59; reference on p. 32.

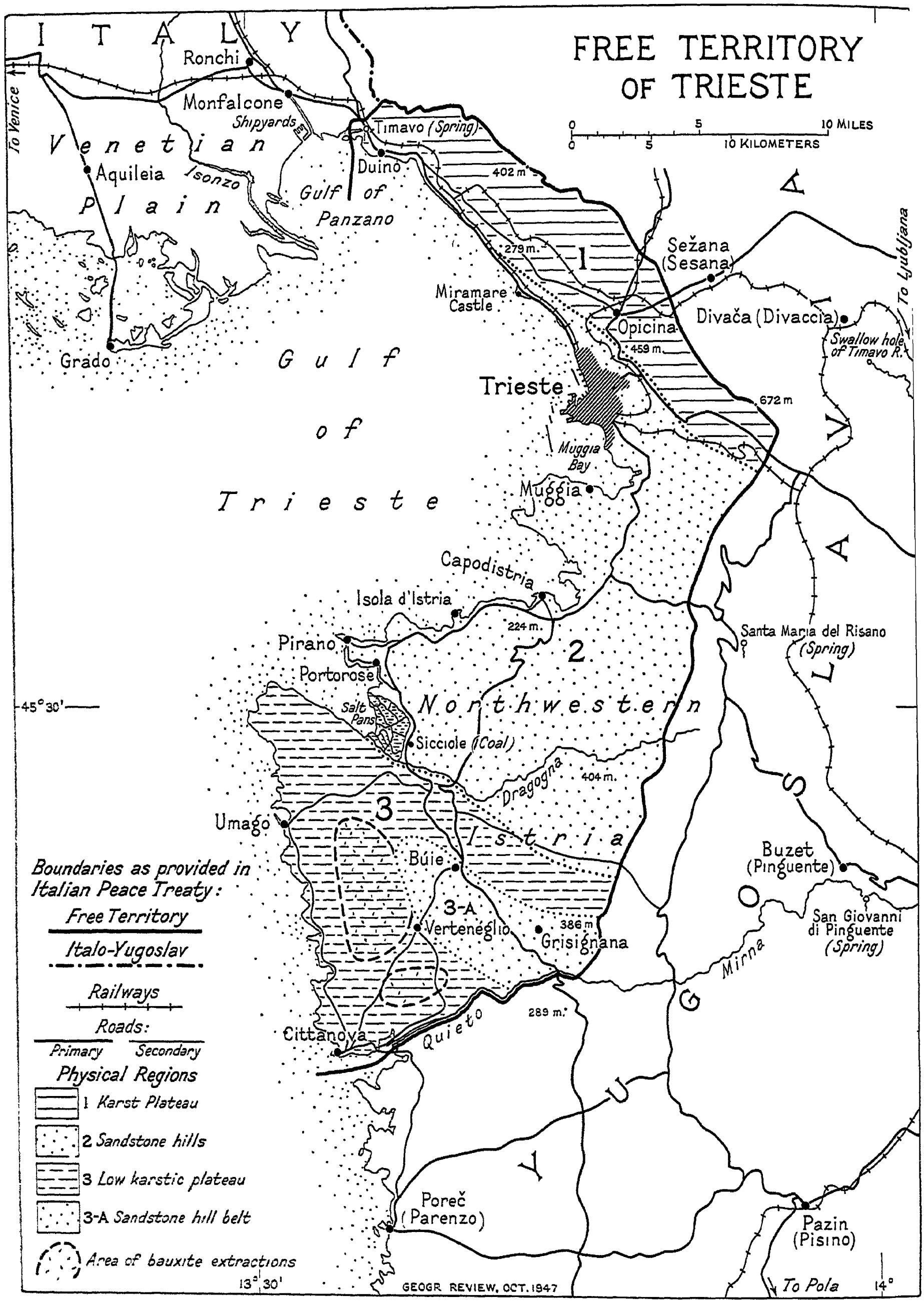

FIG. 2—The Free Territory of Trieste and its economic features. The Timavo spring supplies Trieste; the Santa Maria del Risano spring supplies an area as far west as Pirano, the San Giovanni di Pinguente spring supplies an area as far west as Umago and Cittanova.

For a map showing earlier boundary lines in the Trieste region see Figure 1 (p. 140) accompanying George Kiss: Italian Boundary Problems: A Review, *Geogr. Rev.*, January, 1947.

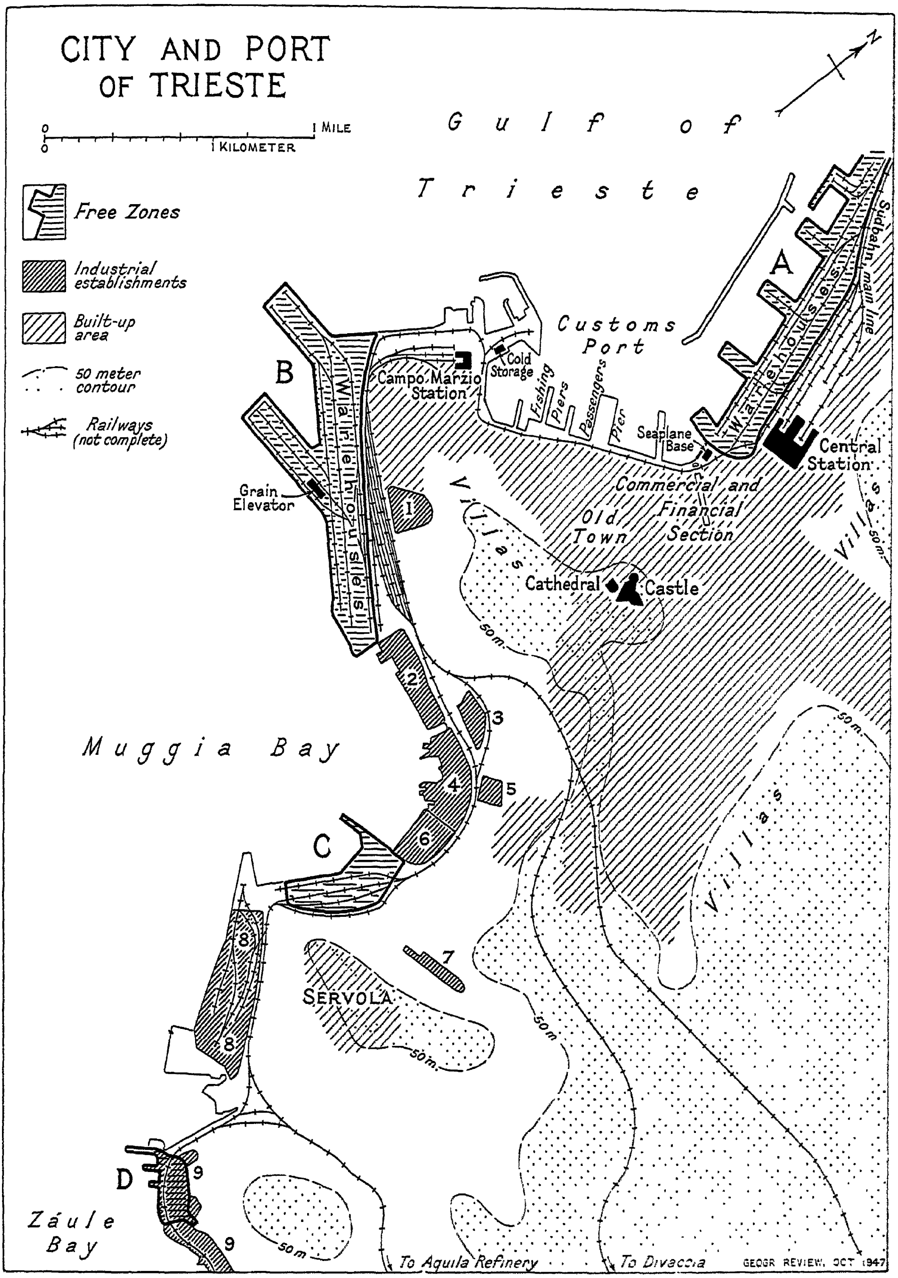

FIG. 3—The city and port of Trieste. Key: A, old general cargo port (Vittorio Emanuele III); B, new general cargo port (Emanuele Filiberto, Duce d'Acosta); C, timber wharf; D, Porto del Petrolio, San Sabba; 1, Fabbrica San Andrea (foundry and engine works); 2, Arsenale Lloyd; 3, crane and bridge works; 4, San Marco Shipyard; 5, jute and hemp works; 6, Gaslini vegetable oil refinery; 7, Angeli rope works; 8, ILVA iron and steel works; 9. San Sabba refinery

remaining corner of the Free Territory. Near Buie and Grisignana this plateau is crossed by a secondary belt of sandstone hills running northwest to southeast. The southern boundary of the Free Territory is formed by the rather spectacular flat-floored valley of the Quieto River, which makes a sharp break in the plateau.

It is estimated that the total area of the Free Territory as defined in the treaty is 276 square miles or 716 square kilometers. The coast line extends for about 80 miles, and the land boundary for 57 miles.

The climate of the Free Territory falls roughly into two categories, based mostly on altitude. Along the seacoast and in low valleys and protected places the climate is that of the Mediterranean, though winters are slightly colder than in peninsular Italy and rainfall is heavier, with winter rather than summer drought.[3] At higher altitudes Central European influences are evident—appreciably colder winters and heavier rainfall, with no pronounced summer deficiency. A sharp boundary runs through the area dividing the vegetation of these two environments. Throughout the Territory blows the infamous bora,[4] a northeast wind that may reach a velocity of 100 miles an hour. In a steady blast lasting for several days this wind precipitously drains the cold air lying over the Karst Plateau and the Danube Basin in winter into depressions appearing over the Adriatic.

Where soils have developed they reflect the type of underlying rock. On the limestone is terra rossa, characteristic of Mediterranean regions; on the sandstone the soil tends toward the fertile brown forest soils, commoner in the Po Plain and Western Europe. But over the larger part of the Territory, the soils are thin and stony, especially in the high rocky Karst in the north where the extreme porosity of the underlying rock contributes to a barren landscape of sparse scrub vegetation and bare white limestone. Limestone painstakingly removed from the fields is to be seen everywhere in the walls and buildings. In northwestern Istria soils are usually loamier, but with much interspersed stony material. The best soils as regards profile development and absence of rocks are in a belt of terra rossa along the west coast of Istria.[5]

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[3] Trieste has an average of 42 inches of rain a year, with an October maximum and a January minimum. January temperatures average 39.4° F., July 74°; the mean maximum is 94°, the mean minimum 23°; days with frost range from 50 to 100. See E. Alt: Klimakunde von Mittel- und Südeuropa (Handbuch der Klimatologie, Vol. 3, Part M), Berlin, 1932, p. 181; also Giotto Dainelli: Atlante fisico economico d'Italia, Milan, 1940, Plate 11.

[4] See E. R. Biel: Climatology of the Mediterranean Area, *Univ. of Chicago Inst. of Meteorology Misc. Repts. No. 13*, 1944, pp. 20–23.

[5] Norbert Krebs, edit.: Atlas des deutschen Lebensraumes in Mitteleuropa, Leipzig, 1937, Plate 4, "Die Böden," by H. Stremme and W. Hollstein.

The Historical Setting

Historically, too, Trieste is in a contact zone, "an area of convergence of contending and expanding political powers."[6] Roman Tergeste, founded by Augustus in the first century before Christ on a site already occupied by the Romans for a hundred years, became a walled strong point of the frontier province of Venetia and Histria, protecting routes from the Venetian plain to the Dalmatian coast. Other Roman settlements were the predecessors of the present towns of northwestern Istria. The disintegration of the Empire left the Trieste region exposed to barbarian attack; between incursions the Patriarchate of Aquileia and the Byzantine Empire reasserted their authority. For a time the region was included in the Frankish Empire of Charlemagne; and when this in turn fell apart, it was replaced by a feudal regime under warring barons whose headquarters usually were outside—in Friuli, Austria, or Istria. The rise of the rival Venetian Republic and Hapsburg Empire had by the middle of the fourteenth century set a pattern for the region of the Free Territory that persisted until Napoleon's time: Trieste and the Karst Plateau were tied to Central Europe across the Alps as part of the Austrian domain; northwestern Istria became a part of the Republic of Venice. Despite the nearness of the Queen of the Adriatic, Trieste fell under her sway for only a few short periods; in fact, in 1382 Trieste sought Austrian protection against Venice, in an effort to avoid complete surrender to the Venetian monopoly over Adriatic trade and the overland connections with inland Europe.

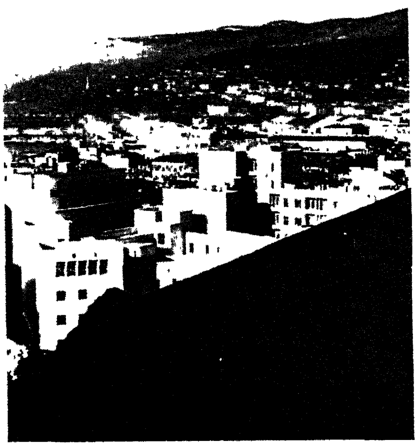
The division between Italy and Austria is apparent to the present day. In northwestern Istria "the pattern of life in the coastal towns and their immediate environs was largely determined by Venetian influence, in a region where few human activities, other than seafaring and its ancillary occupations, are possible."[7] Trieste, on the other hand, shows few Venetian influences and partakes to some degree of the character of a Central European city.

Until the seventeenth or eighteenth century Trieste and Istria functioned primarily as local economies, mostly self-sustaining. Most of the trade moving to the Danube Basin used the Pear Tree Pass. For several centuries

[6] A. E. Moodie: The Italo-Yugoslav Boundary, London, 1945, p. 56 (reviewed in the *Geogr. Rev.*, Vol. 37, 1947, pp. 140–141). Other references consulted on the history of Trieste are: Stjepan Srkulj: Hrvatska Povijest (Croatian History), Zagreb, 1937; "La Marche Julienne," Institut Adriatique, Sušak, 1945; National Liberation Committee of Venezia Giulia: Geographic, Ethnic and Economic Problems of Venezia Giulia [submitted at Trieste to the Commission to Investigate the Italo-Yugoslav Boundary] 1946; G. Gratton: Trieste, clef de voute de la paix, Paris, 1946.

[7] Moodie, *op. cit.*, p. 62.

the population of Trieste probably remained about the 3000 estimated in 1202. Any potential economic development had to contend with the fact that the region, "with no political identity of its own, yet suffering from the military incursions of three of what had become the Great Powers of their time [Venice, Austria, and the Ottoman Empire], . . . was frequently devastated and its people, already occupying a territory where life is always hard, were often reduced to conditions of appalling poverty and pestilence."[8]



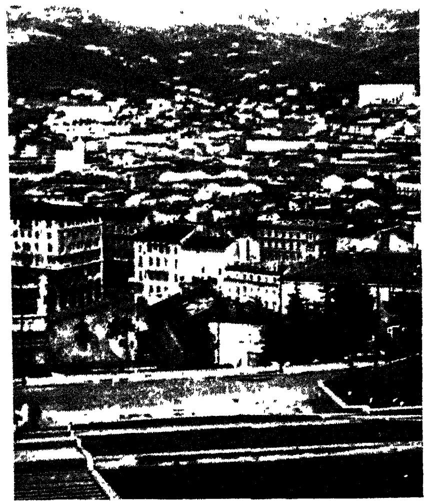


FIG. 4 (left)—General view of Trieste from the Castle hill.
FIG. 5 (right)—Looking north from near the Castle to Opicina on the Karst. The white building in the right distance is the new university building.

As far back as the seventh and eighth centuries, Slavic tribes had entered the region of the Free Territory from the east, and some of them had made permanent settlements. Their numbers were supplemented during the Ottoman advance through the Balkan Peninsula by refugees who came even as far north as this and settled in the inhospitable karstic lands wherever they could find room.

MODERN DEVELOPMENTS

Perhaps the first recognition in modern times of the potential commercial importance of Trieste came when Charles VI of Austria proclaimed freedom of navigation on the Adriatic in 1717 and declared Trieste a free port in 1719. Trade with the Austrian hinterland began to grow. In 1768 a Venetian

[8] *Ibid.*, p. 66.

commission characterized Trieste as a *gran magazzino*, whereas it had formerly been a *miserabile luogo*.[9] Schiffrer says of it at a slightly later date:

The traffic in goods at Trieste is more and more lively and is beginning to attract a large number of stevedores, wagoners, etc. The newly created Austrian merchant fleet needs sailors, laborers for the shipyards, for construction and public works, etc. All this, and, besides, the prosperity and the increased demands of a rapidly expanding city, contributes to make of Trieste a powerful urban center of attraction.[10]

FIGS. 6 AND 7—Views in the old town. On the left the Arco di Riccardo, an arch of the third century A.D. On the right a steep street climbing to the Castle.

No marked increase in the trade of the port came until the middle of the nineteenth century, when Trieste was chosen as the seaward terminal of the Südbahn, Vienna's railroad to the sea. The line, built across difficult terrain by the Austrian government, reached Trieste in 1857. At the same time an artificial harbor was constructed. The shipping and trading experience acquired over the centuries by Istrians and Dalmatian islanders stood the port in good stead on the threshold of its major development. Traffic through the port in gross tonnage of ships was 88,176 in 1810, 206,597 in 1820, and 321,049 in 1830. In this period the ships were primarily Italian. In 1860, three years after the Südbahn was completed, tonnage reached a total of 717,293. In 1869 the Suez Canal was opened, and there

[9] "La Marche Julienne" (*op. cit.*), p. 207.
[10] Carlo Schiffrer: Le origini dell'irredentismo triestino, Udine, 1937, p. 18.

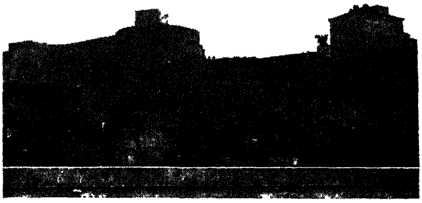
FIG. 8 (left)—The castle with ruin of the Roman basilica in the foreground.
FIG. 9 (right)—The arena.

came a remarkable increase to 960,103 tons in 1870; tonnage was 1,471,464 in 1890, 2,158,624 in 1900, and 5,480,074 in 1913. At this last date ships of the Austrian flag were most numerous, British second.

Concomitantly, commerce and industry in Trieste grew to substantial proportions. Commerce took advantage of the variety of commodities that Central Europe shipped out and of the colonial products that came in bulk from all over the world and were largely processed and packed in the port for shipment inland or, sometimes, for reshipment to another Mediterranean port. Industry centered around the Cantieri, the shipyards which built the Austrian merchant fleet and some of the naval vessels.

In the peace settlement after the First World War, Italy was rewarded with the cession by Austria of what became Venezia Giulia, including all the proposed Free Territory of Trieste. Between the two World Wars the rail and water traffic of Trieste remained approximately as it had been in the later Austrian period, though with considerable fluctuation. In 1938, for example, the tonnage of shipping using the port was 5,871,100; the ships were almost all of the Italian flag.[11] Industry, on the other hand, increased far above the Austrian level, and there were introduced a vegetable-oil refinery, an iron and steel works, a much-expanded and modernized petroleum-refining industry, and a machine, crane, and bridge works. Shipbuilding, however, remained the principal industry. In this period the modern canneries at Isola d'Istria and Umago were established. The peasant farmers lost easy access to the Austro-Hungarian market for their wine and other Mediterranean products and, moreover, found themselves obliged to participate in the "battle of wheat"; northwestern Istria saw many of its vineyards cleared out and sown to grain.

[11] Pierpaolo Luzzatto-Fegiz and others: L'economia della Venezia Giulia, Università di Trieste. Istituto di Statistica, Trieste, 1946, p. 88.



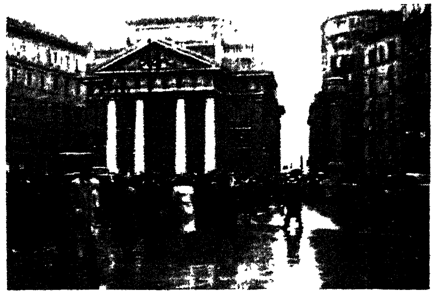


FIG. 10 (left)—The castle and the old town from the roof of the Casa del Popolo.
FIG. 11 (right)—Piazza della Borsa on the day of signing of the Peace Treaty, Feb. 11, 1947.

During the Second World War the city of Trieste suffered less bomb damage than many other European cities, though the port warehouses and, especially, the principal shipbuilding yard and petroleum refinery were badly hit. After liberation from the Germans the city was occupied by the Yugoslav Army for about a month in the spring of 1945. It has since been administered by Allied Military Government. The part of northwestern Istria, however, that is to be included in the Free Territory has remained under Yugoslav Military Government.

POPULATION

According to the Italian census of 1936, the area contained within the boundaries provided for the Free Territory of Trieste in the Italian Peace Treaty had a population of about 343,000. Of this total, 248,000 lived within the commune of Trieste, which consists of the city and its suburban area. The other urban agglomerations are minor; the three larger are Capodistria (7105), Isola d'Istria (6777), and Pirano (5724). Muggia, Buie, Umago, Cittanova, and Verteneglio are the remaining towns, ranging in population from 3000 down to 1000.[12] The rural population of the Free Territory numbers about 70,000. It is concentrated in the south; in the north the inhospitable Karst can support only a meager scattering of agriculturists—perhaps 10 persons to a square kilometer.

Along with the economic development of the city of Trieste that began in the early eighteenth century, its population grew rapidly, especially in the later years of the nineteenth century. At the opening of the eighteenth century the city is reported to have had 600 houses and 5700 people on 34 hectares; in 1785 it had 20,300 people; in 1802, 27,576; in 1857, 104,707; in

[12] Italian census of April 21, 1936, adjusted by the Trieste Communal Office of Statistics to correspond to Free Territory frontiers.

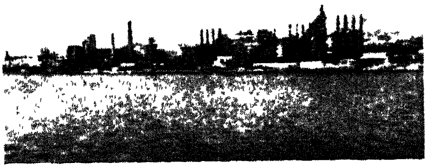


FIG. 12—The ILVA steel works.

FIG. 13—Customs harbor from the Castle.

1900, 176,383; and in 1921, 236,449.[13] Supplementing the growth from natural increase, immigration swelled the population. In 1921, 42 per cent of the inhabitants of the city had been born outside the region (Venezia Giulia)—14 per cent from Italy (pre-World War I boundaries); about 10 per cent from the Gorizia region and another 10 per cent from Istria and Dalmatia; and 7 per cent from elsewhere in the former Austro-Hungarian Empire. Earlier immigration had already established in Trieste a Greek colony of considerable importance in numbers and economic influence, and also groups of Armenians, Albanians, Turks, Egyptians, Swiss, Czechs, Poles, and Jews.

The ethnic character of the Free Territory population has been the subject of innumerable studies and, in the past year, of international investigations and debates. The Austrian census of 1910 and the Italian census of 1921 indicate that the sparsely settled Karst Plateau, extending from the Italian frontier to the city of Trieste, is inhabited primarily by Slovene farmers. Trieste itself is predominantly Italian; but a Slovene minority, which contributes a large number of the industrial workers, lives in the industrial suburbs and peripheral area and in neighboring communes to the east. In northwestern Istria the townspeople are overwhelmingly Italian; most of the rural inhabitants are also Italian, but there are some Slovene and a few Croat agricultural communities, especially in the highly dissected hills in the interior.

Industry is the most important employer in the Free Territory, occupying in 1940 about 16 per cent of the total population and about one-third of the employed population (45 per cent of the total population are employed). Commerce and transport and communications come next with about 12 per cent, and agriculture with 9 per cent. Of a total of some 56,000 workers in industry, more than 47,000 are in Trieste commune; Muggia, an outlier

[13] P. Luzzatto-Fegiz: La popolazione di Trieste (1875–1928), R. Università . . . di Trieste, Istituto Statistico-Economico, Trieste, 1929, pp. 15–16.

FIGS. 14 AND 15—A "bora" day in Trieste, February, 1947.

of the Trieste industrial area, has 3000, and Capodistria, Duino-Aurisina, and Pirano have each about 1000. The transport and commerce workers are also concentrated in Trieste, which has 39,000 of the 43,000 people thus employed; Pirano is the only other commune with as many as 1000. More than two-thirds of the agricultural workers (31,000), however, are in the Istrian communes, where, characteristically, from 30 to 35 per cent of the total population are active in agriculture.[14]

RAILROADS AND POWER

The Südbahn forms Trieste's most important link with the hinterland, carrying over its double-track, electrified line the largest part of the rail traffic. A cutoff from Divaccia shortens the last leg of the Südbahn as it descends into Trieste from the Karst, and provides direct connection with the modern port. Trieste is also linked to Central Europe by two other lines. The first, completed in 1885, passes through Gorizia, Udine, and Tarvisio and provides access to western Austria and southeastern Germany. The Tauernbahn, completed in 1909, climbs the Isonzo Valley north of Gorizia and tunnels twice through the Alps, to provide a somewhat shorter route to Vienna and to Salzburg and Bavaria. To reach Austria the Südbahn crosses Yugoslavia, the Tarvisio route crosses Italy, and the Tauernbahn both. The construction of all three lines was very expensive, and they have rarely paid their way in any strict accounting sense. According to Italian State Railways statistics these three lines can handle a daily traffic of 36,000 tons.

Trieste is also linked to Italy by a double-track line across the Venetian plain, to Fiume by a connection that leaves the Südbahn at San Pietro del Carso, to Pola by a line that traverses the center of the Istrian peninsula, and to Gorizia by a second line, which leaves from the south station (Campo Marzio) and climbs northward over the Karst behind the city.

[14] "Population as of 15-6-1940 According to Activity Groups of the Communes of the Proposed Free Territory of Trieste," Dir. of the Communal Office of Statistics of Trieste, Feb., 1947 (Table).

Adequate to good highways follow these same general routes, but their economic importance, except locally, is not great at present. However, in the Istrian section of the Free Territory there are no operating railroads, and transport must be by motor vehicles and coasting vessels. Much of the fish, wine, vegetables, and fruits from northwestern Istria seen in Trieste markets has arrived on small boats from Isola d'Istria, Pirano, or Capodistria.

There are at present no operating airports in the Free Territory, the Zaule port having been out of use for some time. At least two new favorable sites are under study, and one may be improved in the near future.

The Free Territory is destitute of domestic sources of fuel and power. One coal mine at Sicciole, near Portorose, produced in 1945 between 400 and 500 tons a month of a good quality of bituminous coal. It was estimated that this could be raised to 2000–3000 tons if the proper pumping facilities were installed to keep the mine free of water.[15] The Territory's energy requirements were recognized in the peace treaty by the guarantee to Trieste of an uninterrupted supply of electric power from the sources on which it has been accustomed to draw in the past (Annex IX). The two principal sources—contributing roughly equal amounts—have been the power stations of the middle Isonzo River (Doblari and Plava) and the Piave–Santa Croce group of stations in the Veneto; both formed part of the well-integrated north Italian power grid. The Isonzo plants lie in territory to be ceded to Yugoslavia, the Veneto plants will remain in Italy. According to statistics of the Società Adriatica di Elettricità the area constituting the Free Territory of Trieste has consumed on the average about 150 million kilowatt-hours of electric power a year; industrial reconstruction and recovery might raise this figure to 280 million. Seasonal variations are pronounced: the Isonzo stations are counted on heavily in the spring and autumn; the Veneto group is of prime importance in midwinter and summer. As a safeguard against the failure of either or both of these sources the construction of a waterside thermal station to keep the Triestine economy in steady operation may be considered advisable.

The Port of Trieste and Its Trade

The Port of Trieste extends for about eight miles along the Gulf of Trieste and the Bay of Muggia. It consists of two highly organized, specially equipped ports for the handling of general cargo; a customs port between these two for passenger traffic, the fishing fleet, cold storage, and local business; and a string of wharves and docks along the north shore of Muggia

[15] Estimate, 1946, by the Trieste Chamber of Commerce.

Bay devoted to shipbuilding, ship repairing and outfitting, coal, timber, petroleum, iron and steel manufacturing, and vegetable-oil refining. The bulk of the transit traffic goes through the general-cargo ports, which make up two of the four customs-free zones of the Port of Trieste. In the interwar period the older port was called Vittorio Emanuele III, the newer Emanuele Filiberto, Duca d'Aosta. The other two free zones are specialized: the timber wharf handling the export of timber from Yugoslavia and Austria; and the San Sabba petroleum harbor, with storage facilities and a refinery.

The older of the general-cargo ports lies at the terminus of the Südbahn and was constructed mainly in the period 1867–1883. It can take ships with a draft of 26 feet and has four basins, with ample wharfside space and warehouses alongside served by rail. The new port was begun toward the close of the Austrian period, but no substantial part of it was ready for use until after the First World War, and only two of the three great moles (averaging a little more than 1000 feet in length) called for in the plan have been completed. This port takes ships with a draft of about 29 feet. It was here that the fully loaded Liberty and Victory ships came in recent years with their cargoes of UNRRA goods for Yugoslavia, Czechoslovakia, and Austria, moving on to the older port when partly unloaded. The warehouses and unloading equipment along the docks are of the most modern design and can be adapted to the great variety of commodities that flow across the wharves. In this port is the grain silo which will accommodate as much as 30,000 tons of grain and which can unload about 3500 bushels an hour.

Before the recent war 18,700 tons of goods a day could be unloaded at these two ports, and 282,000 tons stored. The potential handling capacity is reduced, however, by the difficulty of intercommunication; the only means is a one-track line along the water front. In Trieste most of the 17,000 people employed in transport and communications work in the port and its facilities.

Who trades with Trieste and through Trieste? During the recent discussions of the Italo-Yugoslav frontier, claims and counterclaims were put forward. Actually, the hinterland of the port lies mainly beyond the mountains, in Austria and Czechoslovakia, which contributed respectively 34 and 20 per cent of the rail traffic to and from the port in 1937–1938; Italy contributed 25 per cent. The other percentages were: Hungary, 8; Yugoslavia, 6; Germany, 5; and Switzerland, 3.[16] The new boundaries provided in the Peace Treaty bring some of the territory on which the Italian trade was based into Yugoslavia, and much of it into the Free Territory itself.

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[16] Rodolfo Bernardi: Trieste Traffic in the Light of Official Statistics, Trieste, 1946.

During the days of the Austro-Hungarian Empire, Trieste, indisputably the principal port, had little difficulty in attracting a large part of the Danubian and Central European overseas trade. In 1910, for example, it handled 21 per cent of Austria's overseas imports and 18 per cent of the exports. Moreover, its location and political advantages were strengthened by a system of so-called "Adriatic rates," which set up special tariffs advantageous to the users of Trieste. At the close of the Austrian period sea traffic had reached the all-time high of 3.4 million tons, almost but not quite equaled in 1938, and rail traffic had risen to 2.7 million tons, exceeded subsequently only once, in 1924.

Between the World Wars Trieste found itself cut off politically from the larger part of its hinterland and in competition with the highly subsidized German North Sea ports, which were being assisted by a variety of political and economic devices. Moreover, the era of economic nationalism and self-sufficiency was at hand, and the total volume of trade was decreasing. One factor in Trieste's favor was that the Adriatic rates were at least nominally kept in force in much of the hinterland, as treaty obligations. That the port managed even to maintain its position in this period is some measure of its natural advantages.

Because of its entrepôt service to neighboring Adriatic ports, and because of the processing industries in the city itself, more of the goods that move through Trieste come and go by water than by rail. It is difficult, from past statistics, to designate any particular overseas areas as the natural areas for trade with Trieste, since shipping lines in Fascist Italy had carefully prescribed routes and such factors as the Ethiopian war also distorted the trade picture. Nevertheless, Trieste has an obvious natural advantage in trade with the Mediterranean area, the Near and Far East, and South America, in serving its hinterland. On the other hand, goods moving across the North Atlantic or through the North and Baltic Seas would reach all but the nearest parts of Trieste's hinterland more easily by way of North Sea and Baltic ports. In 1937–1938 water-borne traffic to and from Trieste was as follows: Italy, 30 per cent; Levant and Black Sea countries, 16; East Indies and Far East, 14; United States, 11; Netherlands, 7; Argentine Republic, 4.

The principal commodity moving through the port before the war was petroleum, both crude and refined, and its products, about 986,000 tons in 1938. More than half came from the United States and Latin America; the British East Indies and the Levant supplied most of the rest. The petroleum (some was refined in Trieste) moved principally to Austria, Italy, and Switzerland.

The trade in metallic ores was 670,000 tons in 1938. The ores came chiefly from Northwestern Europe, the Levant and Black Sea countries, and North Africa (presumably iron); Austria supplied magnesite, and Italy some zinc from the Predil mines near Tarvisio. Austria, Italy, and Czechoslovakia took a large part of these ores, and a great deal was consumed by Trieste industry. The magnesite went chiefly to the United States.

Austria and Yugoslavia shipped large amounts of timber through Trieste, and Austria and Czechoslovakia sent wood products, chiefly paper, cardboard, and wood pulp. In 1938 these commodities totaled about 470,000 tons. They were shipped from the port to almost all its overseas markets. About 440,000 tons of iron and steel passed through Trieste, coming from Austria, Czechoslovakia, and Northwestern Europe and going primarily to Italy. Coal, from Northwestern Europe, the United Kingdom, and Czechoslovakia, was next in importance—about 350,000 tons in 1938. Almost all of it was either consumed locally or forwarded to Italy.

Oil-bearing seeds and fruits were imported in large quantities, part in transit, part for consumption in the local refinery and shipment on vegetable oil and oil cake. Of the 260,000 tons in 1938, the largest amounts came from the British and Dutch East Indies and India; they were shipped primarily to Austria and Italy, but also to Switzerland, Yugoslavia, and Hungary.

Fresh and dried fruits and vegetables, sugar, cereals, and raw cotton are, respectively, the next in importance, with tonnages ranging from 250,000 to 100,000 in 1938. Italy and the Levant countries contributed the larger part of the fruits and vegetables (including citrus), and these went by rail to Czechoslovakia, Germany, and Austria. The sugar came almost entirely from Czechoslovak beets; the cereals from Latin America, Hungary, and the Black Sea countries; and the cotton from Egypt and Turkey, the United States, and India. The Levant countries and Africa (presumably the East African colonies of Italy) took most of the sugar, Austria and Italy the cereals, and the whole range of hinterland countries, but principally Czechoslovakia, the raw cotton.

The trade of Trieste is clearly weighted heavily on the side of bulk commodities. Coal and minerals account for about a quarter of the movement of goods, petroleum for about 15 per cent, and cereals for some 6 per cent. If timber, wood pulp, oilseeds, sugar, and cotton are also taken into account, it is apparent that considerably more than half of Triestine trade is composed of heavy, relatively low-value goods.

Although certain natural advantages, developed by port and railroad construction, must account primarily for Trieste's trade volume, credit

must be given also to the skill and broad experience of its population of traders. These men have contacts throughout Central Europe and in ports all over the world. They know at any given time where goods can be obtained, who will buy them, and at what prices; they have excellent credit and banking arrangements and insurance facilities; they know how goods should be packed and shipped, billed, and accounted. Thus the widely separated producer and consumer have often found it easier to depend on the Trieste merchant to move goods. The independent trader has no longer such bright prospects, however, because of the increasing use of monopolistic state trading companies, and it is probable that this group will be of relatively less importance in coming years. According to the 1936 census, 21,000 persons were employed in commerce in Trieste—a high proportion, namely 8.4 per cent.

Manufacturing and Processing

The Free Territory of Trieste is small enough to permit the study of its individual industrial enterprises. Most of the industries have obvious connections with the port, while almost none of them depends on the resources of the surrounding countryside. The Cantieri Riuniti dell'Adriatico is the organization of predominant importance in Trieste, and also in Monfalcone, just across the new Italian boundary to the north. The Cantieri is made up of several separate enterprises, dating from the early nineteenth century, which were assembled in 1930 into one firm. In Trieste, and across the bay in Muggia, the Cantieri has two shipyards with nine ways in all and a dry dock. Two of the ways can build ships of 50,000 tons, and two of 10,000 tons. These yards are not as modern as those in Monfalcone, and the San Marco yard was severely damaged by bombing. Nevertheless, they are already turning out a number of vessels, and orders to keep the yards busy for several years are reported to have been placed already. Under Italian rule the larger part of the output was taken by Italy, but ships also were sold all over the world.

Of the materials for the shipyards, those of local manufacture include some of the rougher steel plates fabricated at the ILVA plant (iron and steel), the Diesel and other nonelectric engines, and various cranes and other lifting and carrying equipment; almost everything else is imported. In this connection two of the other Cantieri enterprises in Trieste may be introduced—the Fabbrica San Andrea and the Officine Ponti e Gru. The former is a foundry that casts heavy metal and machine parts and constructs the largest and most modern types of Diesel marine engines, steam turbines, and ships' auxiliaries. It produces both for the near-by shipyards and for export. The

second enterprise, the crane and bridge works, has provided many of the myriad cranes and hoists that line the wharves of Trieste and numerous other ports all over the world. It has also supplied the material and engineering skill for the construction of bridges, tanks, and the like throughout Central Europe and as far away as Egypt and South America. These are additional sources of foreign exchange for the Free Territory. To be sure, all the raw materials that go into this production must be imported, but the local skilled labor and management should be able to contribute enough to keep these industries prosperous. All told, the Cantieri enterprises employ today about 15,000 men in Trieste and Muggia.[17]

Next in importance is the group of industries that process crude or bulky imports from overseas and re-export the refined or manufactured product. It is estimated that 30 per cent of the goods passing through Trieste are handled in some fashion by these industries. Chief among them are petroleum and vegetable-oil refining, jute and hemp milling, tobacco manipulation, and coffee roasting. The raw materials come in general from areas with small capital and unskilled labor by cheap ocean transport. It is clearly in the interest of economy to reduce their bulk and increase their value per unit of weight before starting them on their overland journey, and Trieste is well equipped to perform this function.

When, in the 1880's, petroleum and its products first became important, a refinery for crude petroleum was built at San Sabba. It was expanded from time to time and supplemented with storage facilities, and it was eventually constituted as the fourth of the free zones of the port. In 1936, as a result of the greatly increased importance of oil, a new and modern refinery was built across the bay from San Sabba, the Aquila. Aquila's refining capacity before the war was 350,000 tons of crude petroleum a year, and its storage capacity 100,000 cubic meters; San Sabba's, 100,000 tons and 67,000 cubic meters.[18] Italy normally took about 70 per cent of the total production. Aquila was severely damaged by bombs but was reported to be about ready to begin operations again in the spring of 1947. The refineries employed about 570 men, about 300 at Aquila and 270 at San Sabba.

The war years saw a substantial development of petroleum production in Hungary and Austria. Austria had been the destination of about 20 per cent of the oil that passed through, and was refined in, Trieste, and it seems not unlikely, therefore, that some reduction in this trade will take place.

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[17] Luzzatto-Fegiz and others, *op. cit.*, p. 76; and information in the files of the Allied Military Government, Venezie Giulia.

[18] These and following figures from statistics in the files of the Allied Military Government, Venezia Giulia.

Oilseeds are pressed in Trieste at the Gaslini mill, near the San Marco shipyard. There is also a mill at the head of Muggia Bay, which is idle at present but might be brought back into use. The oil is expressed from cottonseed, linseed, soya, sunflower, copra, and other vegetable-oil sources. The normal output has been about 45,000 tons of edible oil and 90,000 tons of cattle food a year; an average of several hundred workers are employed. Italy has taken the entire output of vegetable oil in the past.

The jute and hemp factory (Jutificio e Canapificio) ordinarily uses mostly jute from India for the manufacture of ropes, gunny, and so on. At the present time, however, it is limited mainly to hemp, since it can obtain this from Italian domestic production. The plant finds a ready market for its products in the ships and warehouses in the harbor of Trieste and other Mediterranean ports, and in the binding and sacking requirements of the agricultural hinterland.

Tobacco has its work space in one of the port's warehouses. There the leaf from Greece, Russia, and Turkey is split, sorted, and otherwise processed for reshipment, and Trieste has thus become the regional tobacco entrepôt, though it manufactures no tobacco products. Supplies of Oriental-type tobacco are often purchased here. Manipulating the tobacco gives employment to as many as 3500 people. Food industries depending on overseas imports to produce for a larger market than the local one are coffee roasting, liqueur distilleries, a large brewery, and some jam and confectionery manufacturing.

ILVA is a subsidiary of a large Italian firm of the same name. The Trieste plant consists of six blast furnaces (five electric), a steel mill, and a coke and gas works. The annual output for 1938–1940 included 150,000 tons of pig iron, 70,000 tons of steel ingots and plates, and 170,000 tons of coke. The by-products were 25 million cubic meters of gas for Trieste, ammonium sulphate, benzine, tar, and slag. The only locally available raw material for the blast furnaces is limestone. Coal has usually come from the Ruhr or Czechoslovakia. Italy has supplied some of the iron ore, but the larger part has come from North Africa, Yugoslavia, and elsewhere. ILVA products are high-cost ones, but in Italy, which lacks most of the natural prerequisites for a steel industry, Trieste was perhaps better situated than many places.

Part of ILVA's output is taken by the shipyards—about 15,000 tons of the rough steel plates. Most of it, however, has gone to Italy; whether this will also be its future market depends a good deal on the customs arrangements set up between the Free Territory and Italy. Other markets for these iron and steel products, when once the present world shortages have

been met, are not so apparent, though the industries of Trieste may be able to take a substantial part of the output. ILVA employs about 1300 workers.

There are several industries in the Free Territory outside the city of Trieste that are worth noting. Principal among these are the canneries of the Ampelea company at Isola d'Istria and of the Arrigoni company at Isola and Umago. These three plants are fairly modern and well equipped. They are devoted chiefly to the preserving of fish, but the Arrigoni plants have undertaken the preparation of tomato paste, meat extracts, and jams and marmalades as well, for which they manufacture their own cans. The plants are all at the water's edge, where they receive from the fishing boats the anchovies, sardines, pilchards, tunny, mackerel, and herring from Mediterranean (primarily) and North Sea waters. The tomatoes and fruits come mostly from the surrounding countryside. Central and Danubian Europe, as well as Italy, have taken the products of these canneries and may be expected to continue to do so. When working at capacity, the plants employ more than a thousand persons. They are a sure buyer for the fishermen of the region, some of whom are also employed on shares.

The building of wooden ships may well date from Roman times in Istria, but it certainly flourished in the Venetian period. Today there are still in operation several yards that build fishing boats and other wooden craft of high quality—Capodistria, Isola d'Istria, and Pirano have each such a yard—and find a ready market in the neighboring ports and among the local fishermen.

There is also a large saltworks just south of Pirano, which takes advantage of the extensive marshes at the mouth of the Dragogna River. These have been diked and regulated for flooding and drainage, and the hot summer sun does the other necessary work. Venice depended on this salt for many centuries; it is now sold widely in the region.

The cigarette-paper industry in the city of Trieste completes the roster of Free Territory industries. This has supplied a substantial fraction of the cigarette-paper requirements of the Italian tobacco monopoly; the rough paper comes from Italy.

Shipping, Insurance, and Tourism

As goods moved in increasing amounts through the port of Trieste, an incentive was afforded for the development of local shipping companies to transport them. In addition, there were the hundreds of thousands of Central European emigrants, especially in the later nineteenth century and early

twentieth, who came to Trieste to embark for America. Such lines as the Austrian Lloyd, founded in 1836, and Cosulich, an independent line founded in 1903, became known throughout the world. After the First World War, Cosulich continued under the same name; the Austrian Lloyd became Lloyd Triestino and in the 1930's was largely taken over by the Italian state. Many other lines were established in this period, and it is interesting that most of the owners in themselves reveal one of the principal sources of the shipping skill and experience of Trieste, namely the men from the island of Lussino, which lies off the southeast coast of Istria. Cosulich is one; others are Tripcovich, Premuda, Martinolich and Gerolimich. These men are represented today in almost every important enterprise in Trieste.

The war took its toll of Trieste shipping and has left the Free Territory with almost no ocean-going ships. There are many evidences, however, that the old shippers are ready to start again, and they and some new operators will probably be able to rebuild the merchant marine to a reasonable level rather soon. Additions to the existing business may come as a result of the peace-treaty clause that permits the registry in Trieste of ships of a Czechoslovakian, Swiss, and, later, Hungarian and Austrian merchant marine.

A useful adjunct to the shipping industry is the Arsenale Triestino, near the San Marco shipyard, where all kinds of ship repairs are made.

The Austrian period saw the growth in Trieste of a number of insurance companies. Two have become world-famous and are perhaps the principal insurance businesses on the Continent—the Assicurazioni Generali, founded in 1831, and the Riunione Adriatica di Sicurtà, founded in 1838. Inevitably, however, these companies, their world-wide assets and business connections severely curtailed by the war and the peace treaty, will play a declining role in coming years; because their financial ties are now chiefly with Italy, they have recently decided to move their headquarters there, though important offices will remain in Trieste. In the past the offices of the insurance companies have employed about 2500 persons.

Those Central Europeans who can afford it look to the Adriatic as a vacation place, in summer and in winter. Here are swimming, sailing, sunshine, and generally pleasant weather. The Free Territory, with its direct rail connections, can attract some of this resort and tourist trade, and to some extent it is provided with facilities to care for visitors. The principal resort is Portorose, in a protected site on the south shore of the peninsula at the tip of which Pirano stands. It would seem that Trieste could also make into tourist attractions the castles at Miramare and Duino and the pleasant towns of the Istrian coast, with their Venetian character and seashore

facilities. Moreover, the unique status of the Free Territory may serve to draw intergovernmental conferences and international meetings of scholars and other groups.

Rural Economy and Fishing

Rural economy clearly will play only a small part in the life of the Free Territory, with its infertile soil, yet the agricultural community has some significance in the food and exports it can contribute. As was noted earlier, the country east and north of Trieste offers little to the farmer because of the infertility of the rocky, porous, highly calcareous soil of the Karst. Farms here average between five and ten hectares, and only about 5 per cent of the farm area is sown to crops, principally potatoes, hay, beans, and rye.[19] In many parts cultivation is confined to the *dolini*, at the bottoms of which enough moisture and soil have collected to make plowing and planting worth while. Most of the rest of the land is in permanent pasture or sparse, scrubby woods, and the remainder is entirely unused. Some vineyards, orchards, and vegetable gardens are found in favored spots on west-facing slopes where the Karst drops sharply to the sea, especially near the city of Trieste.

In northwestern Istria the Dragogna Valley and the restricted lowlands around Capodistria and Isola d'Istria are devoted to an intensive, commercialized farming on very small holdings, usually between two and five hectares. Potatoes, fresh vegetables (cabbage, cauliflower, asparagus), and tomatoes are the main crops; a part of these has customarily been sold to Central and Northern European markets when such products were out of season there. Wine (also for export), cherries, figs, peaches, maize, beans, and olives are also produced here, and dairying is of some importance. In this part of the Free Territory is found the most intensive use of land, the commune of Capodistria having more than 60 per cent of the total area of farm and woodland sown to crops.

Farther to the west, around Umago and Buie, agriculture more closely approaches the Mediterranean type. Vineyards, olive groves, wheat, beans, and some fruit trees predominate. Farms are slightly larger, averaging about five hectares. The pasturing of sheep assumes more importance. On the average, between 30 and 60 per cent of the land is in cultivation.

As might be expected, agricultural yields are generally low. Wheat yields, for example, average less than 10 quintals to a hectare, as compared with more than 25 in the Po Valley; potatoes yield fewer than 50 quintals to a hectare, as compared with about 150 in the Po Valley. Vine and

[19] Dainelli, *op. cit.*, Plate 39.

fruit-tree yields, however, are relatively higher.[20] Most of the farmers in the Free Territory own their own land.

In sum about 17,500 hectares in the Free Territory is under cultivation, and an additional 8900 is in vineyards, orchards, and the like. It is estimated that on this land the following chief crops were produced, 1936–1938 average, in quintals a year: grapes, 280,000; potatoes, 260,000; wheat, 91,000; corn, 90,000.[21] If Zone B only is considered (south of the Morgan Line in northwestern Istria), the following information is available: beans, 9600; olives, 5000; barley, 2200; fruits, 2000.[22]

The Free Territory is not well forested, and forest activities play only a minor role in its economy. Forests occupy about 17,700 hectares. Much additional land useless for other purposes could be reforested to reduce the dependence on wood imports.

In 1937 about 30,000 tons of bauxite was extracted in the Territory from deposits lying east of Umago and Cittanova. These are some of the most thoroughly worked-out of the Istrian bauxite deposits, and their output may be expected to decline.[23]

Fishing ports, large and small, line the coast of the Free Territory and send their fleets out into the Adriatic. The fishing grounds just off the Trieste coast are said to be "one of the richest fishing zones of all the Italian seas."[24] An average yearly catch of about 4500 tons is brought back, consisting primarily of sardines, pilchards, and mackerel. All the catch is consumed locally, either fresh or canned. Isola d'Istria, with its two great canneries, is the principal fishing port; Capodistria and Cittanova come next. Much of the fishing is well organized, and the larger part of the catch is taken from motor ships. Much of the pilchard fishing is done at night, with the aid of lamps. Shellfish are locally important, especially at the head of Muggia Bay at Zaule, and some are sufficiently well known to be exported. The chief types are oysters and mussels.

There are 60,000 to 65,000 persons actively engaged in, or dependent on, agriculture, hunting, and fishing in the Free Territory. The peasant farmers on the Karst, if not too far removed from transit facilities, may spend as much time working in Trieste as in tending their farms; in coastal Istria fishing may occupy much of the farmer's time. Inland, however, and

[20] Ibid., Plates 42, 47, 50 and 51.

[21] Statistics in the files of the Allied Military Government, Venezia Giulia.

[22] Statistics of the Yugoslav Military Government.

[23] Umberto Sorasio: Notizie sui giacimenti di bauxite istriani, Trieste, 1946; and documents in the files of the U. S. Department of State.

[24] Luzzatto-Fegiz and others, *op. cit.*, p. 59.

especially in the hilly country, are the exclusively agricultural, peasant communities where a much higher proportion of the daily necessities is raised on the farm. Here life may still revolve around a closely built little town perched on a hilltop as protection against the enemies that have plagued it since the end of the Pax Romana.

Economic Outlook

The Free Territory of Trieste will consist essentially of a city with well-developed industry and a modern port serving an extensive hinterland in Danubian Europe. Around the city lies a small territory with few resources and a production that can meet only a fraction of the requirements of the Free Territory's population and industries.

The local agricultural production can supply Trieste with an estimated 185,000 quintals of cereals and limited quantities of potatoes, vegetables, fruits, wine, and fish. But it is estimated that to feed the population of the Free Territory in the coming year about 530,000 quintals of cereals will be required, as well as many other foods. This requirement makes up about one-fourth, in value, of the goods and services that must be imported to keep the Free Territory alive and functioning.

The electric power to operate industries and utilities and to provide light and heat is transmitted from the Isonzo stations and the Veneto; it must be paid for. This is also true of the water supply for northwestern Istria. Together these make up about 2.4 per cent of the import requirements. Coal is needed from outside as well, some for the ILVA furnaces and other industrial uses, some for heating, and some for bunkering the ships that use the port; this will use up roughly 7 per cent of the import budget. The industries of Trieste are almost entirely dependent on imports for their raw materials—chiefly oilseeds and fruits, crude petroleum, iron ore, and scrap—and for machinery and equipment, and these items add 50 per cent to the mounting bill. Lastly there is the variety of consumer goods, including tobacco, which the population demands. Many commodities are fabricated locally, but such major needs as textiles and clothing must be brought in from abroad—14 per cent more added to the import bill.

In the past much the largest part of the above-mentioned goods came from Italy, and much will certainly continue to do so, but the existence of a political and financial barrier between Italy and the new Territory will undoubtedly divert some of the latter's buying to other sources. How extensive these changes will be depends on the nature of the barriers, not only vis-à-vis Italy, but also with Yugoslavia and elsewhere. The new situation

may also reduce Italy's formerly extensive purchases of goods and services in the Free Territory, but to what extent it is impossible to estimate.

The goods and services which the Free Territory can produce to sell abroad in the coming year will, it is optimistically estimated, be able to meet the necessary expenses for imports from abroad, if markets can be found for these products. An important source of income from abroad, perhaps 22 per cent, is the sale of the products of the shipyards, including the industries related to the Cantieri. ILVA could account for about 9 per cent, and the petroleum and vegetable oil refineries, the canneries, the jute factory, and several smaller enterprises for an additional 40 per cent. The activities of the port earn Trieste 10 per cent more and the shipping lines another 6 per cent. Agricultural and miscellaneous exports contribute another 4 per cent. These estimates are derived principally from the conclusions of the Trieste Commission of Inquiry, which studied the economic situation in Trieste in January and February of 1947 under instructions from the Council of Foreign Ministers.

It is clear that Trieste's economic position is dependent on a relatively free movement of goods in world trade. Any strong trend toward economic nationalism, especially in the countries of the hinterland, cannot but decrease the prosperity of the Territory, where any thought of self-sufficiency is obviously absurd. Moreover, the Territory is exposed to various kinds of economic discrimination, which might be applied for political reasons and which could reduce the business of the port far below levels required for economic operation, given its present development and capital investment.

But there is no doubt about the natural economic advantages that Trieste has as the funnel for imports and exports of Danubian Europe, and as a processor of the goods that pass through this funnel. If reasonably amicable political conditions prevail and world trade can be restored to the levels of the period before the World War just past, the Free Territory can expect to provide its citizens with useful work and a satisfactory level of living.

A GEOGRAPHICAL SKETCH OF KIANGSU PROVINCE

HUAN-YONG HU

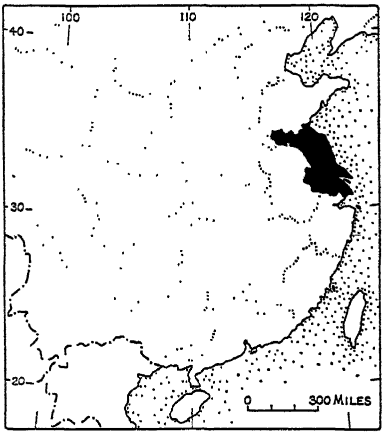


FIG. 1—Kiangsu Province

KIANGSU, the second-smallest province of China, is made up largely of the emerged delta plains of the Yangtze, the Hwai Ho, and the Hwang Ho with a few scattered hills in the southwest and northeast corners. Climatic conditions change gradually but noticeably from north to south. Differences in soil reaction and texture are marked. Slight though they are, variations in elevation and the consequent drainage pattern also tend to emphasize regional diversity. Truly the province is a region of contrasts. Nevertheless, in the main, Kiangsu represents a vital zone of transition between North and South China.

The estimate of 1936 gave this province of 41,250 square miles a population of 36,469,321; the average density was therefore 884 to a square mile (341 to a square kilometer), making it one of the most densely populated regions in the world. Within its political limits lie China's two greatest centers: Nanking, the political capital, and Shanghai, the economic capital. Even more significant is the fact that between these two capitals is a string of urban centers, which, with Nanking and Shanghai as the poles, form the only area of highly concentrated population in the country large enough to be comparable with the great conurbations of Europe and North America.

CLIMATE

Precipitation decreases from about 1100 millimeters (43 in.) in the south to 700 millimeters (27.5 in.) in the north (Fig. 4); the number of rainy days decreases from about 130 to 50 in the same direction (Fig. 5).

Tables I and II show clearly that the northward decrease in the number of rainy days is more remarkable than in the rainfall. Southern Kiangsu not only receives more rainfall in summer but also has more rainy days in winter, because of the great frequency of cyclones passing along the Yangtze Valley in the cold season; there are more clear days and longer duration of sunshine in northern Kiangsu, especially in winter. At Shanghai

TABLE I—RAINFALL OF KIANGSU PROVINCE (*In millimeters*)

	J	F	M	A	M	J	J	A	S	O	N	D	Year
Shanghai	50	59	83	93	93	176	145	142	127	71	52	37	1128
Nanking	40	46	62	97	78	156	182	111	83	45	41	36	977
Nantung	28	37	50	67	64	150	174	131	124	25	40	39	930
Chinkiang	40	44	69	90	87	165	182	121	95	45	45	42	1018
Kiangtu	35	50	64	89	77	167	212	168	131	21	30	25	1072
Fowning	31	26	26	51	54	102	197	137	62	31	27	35	781
Hwaiyin	18	22	25	84	70	115	161	92	80	35	25	51	779
Kwanyun	25	25	30	55	65	105	141	147	67	20	14	23	720
Kanyu	43	35	35	52	25	92	197	231	30	13	25	24	803
Suchien	31	26	26	37	37	95	206	181	72	20	18	21	770
Tungshan	16	17	22	58	42	102	122	139	76	23	23	32	674

TABLE II—RAINY DAYS

	J	F	M	A	M	J	J	A	S	O	N	D	Year
Shanghai	10	10	12	13	12	14	11	11	12	9	8	8	130
Nanking	9	9	10	11	10	12	13	12	10	8	8	9	121
Nantung	7	8	10	10	10	12	12	12	11	5	8	9	114
Chinkiang	7	7	10	10	9	10	11	10	10	6	6	7	103
Kiangtu	5	5	7	7	7	8	9	9	8	4	5	4	78
Fowning	4	5	4	7	6	7	12	11	6	3	5	6	76
Hwaiyin	4	5	4	7	7	7	10	10	5	3	3	5	70
Kwanyun	4	2	3	4	4	4	7	5	5	3	3	4	48
Kanyu	5	5	5	5	3	6	7	9	3	1	4	5	58
Suchien	5	4	4	5	4	6	9	9	4	2	3	4	59
Tungshan	4	4	3	5	4	5	7	6	3	1	2	3	47

TABLE III—TEMPERATURE (*In* ° C.)

	J	F	M	A	M	J	J	A	S	O	N	D	Year
Shanghai	3.2	4.1	8.0	13.5	18.8	23.1	27.1	27.0	22.8	17.4	11.3	5.8	15.2
Nanking	2.2	3.7	8.6	14.5	20.3	24.4	27.7	27.5	22.8	17.2	10.6	4.6	15.3
Nantung	1.6	3.0	7.4	13.0	18.7	22.8	26.9	26.9	22.4	17.3	11.2	5.0	14.7
Hwaiyin	−0.2	3.0	8.8	14.5	21.0	25.7	28.7	28.3	23.7	17.5	10.3	3.6	15.4
Kwanyun	0.8	1.4	8.2	13.4	20.8	25.4	29.2	28.8	23.4	17.2	9.9	3.1	15.1
Kanyu	−0.9	1.5	6.9	13.5	19.5	24.1	26.7	26.5	22.4	17.8	8.6	1.1	14.0
Tungshan	−0.9	1.6	7.7	13.7	20.2	25.6	28.2	26.8	22.0	15.7	8.2	2.0	14.2

the greatest annual rainfall ever recorded was 1602 millimeters; the lowest at Tungshan was only 259 millimeters.

Temperature differs less than rainfall between south and north. The mean annual temperature of Shanghai is 15.2° C., that of Tungshan 14.2°—a difference of only 1° C. The July temperatures are 27.1° and 28.2° respectively, an equally small difference. The contrast in winter temperatures is more conspicuous; the January temperature at Tungshan is −0.9°, which is 4.1° lower than that at Shanghai. There is no month with zero temperature in southern and central Kiangsu, whereas the January temperature of northern

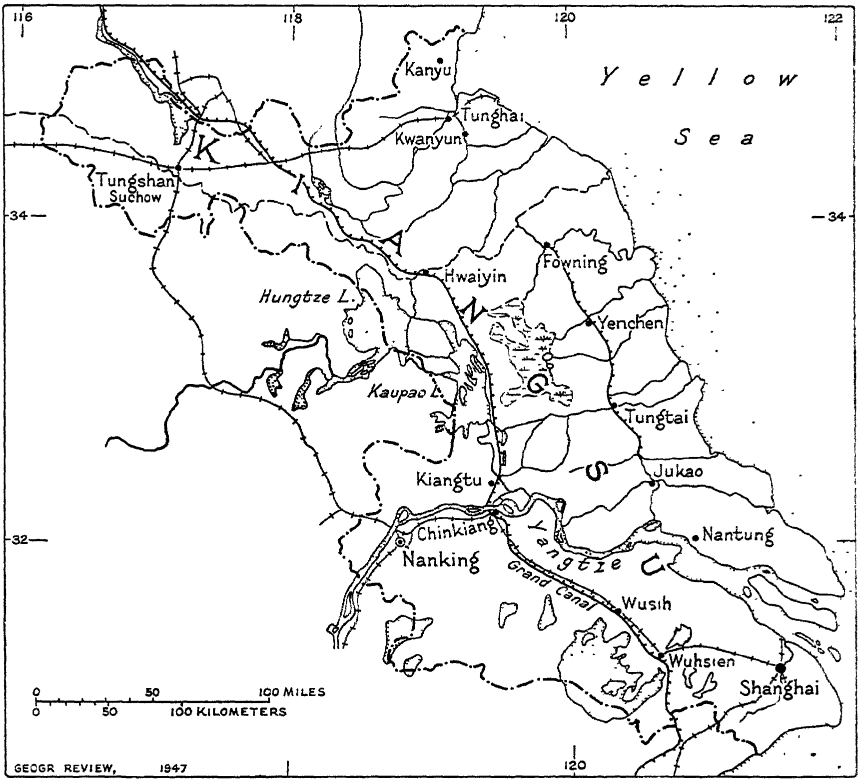


FIG. 2—Location map of Kiangsu Province.

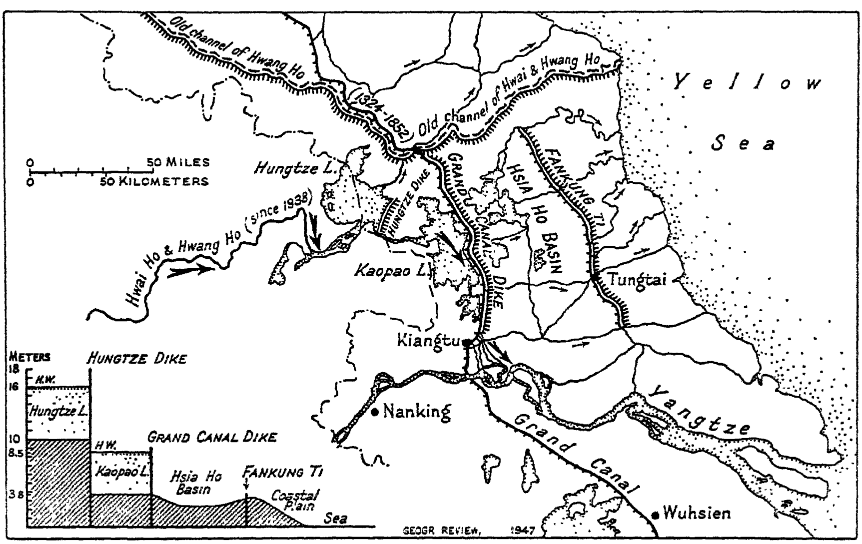
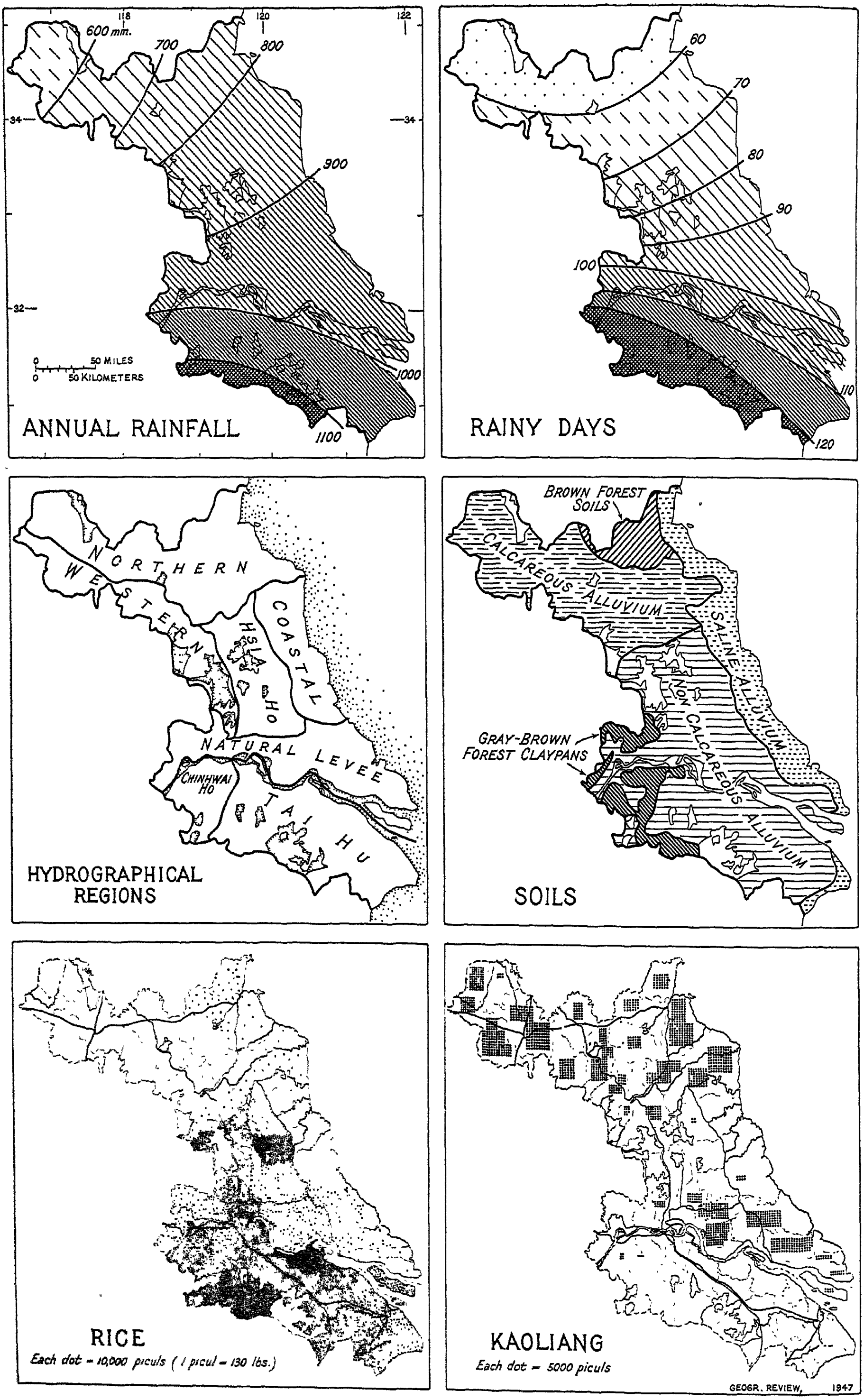
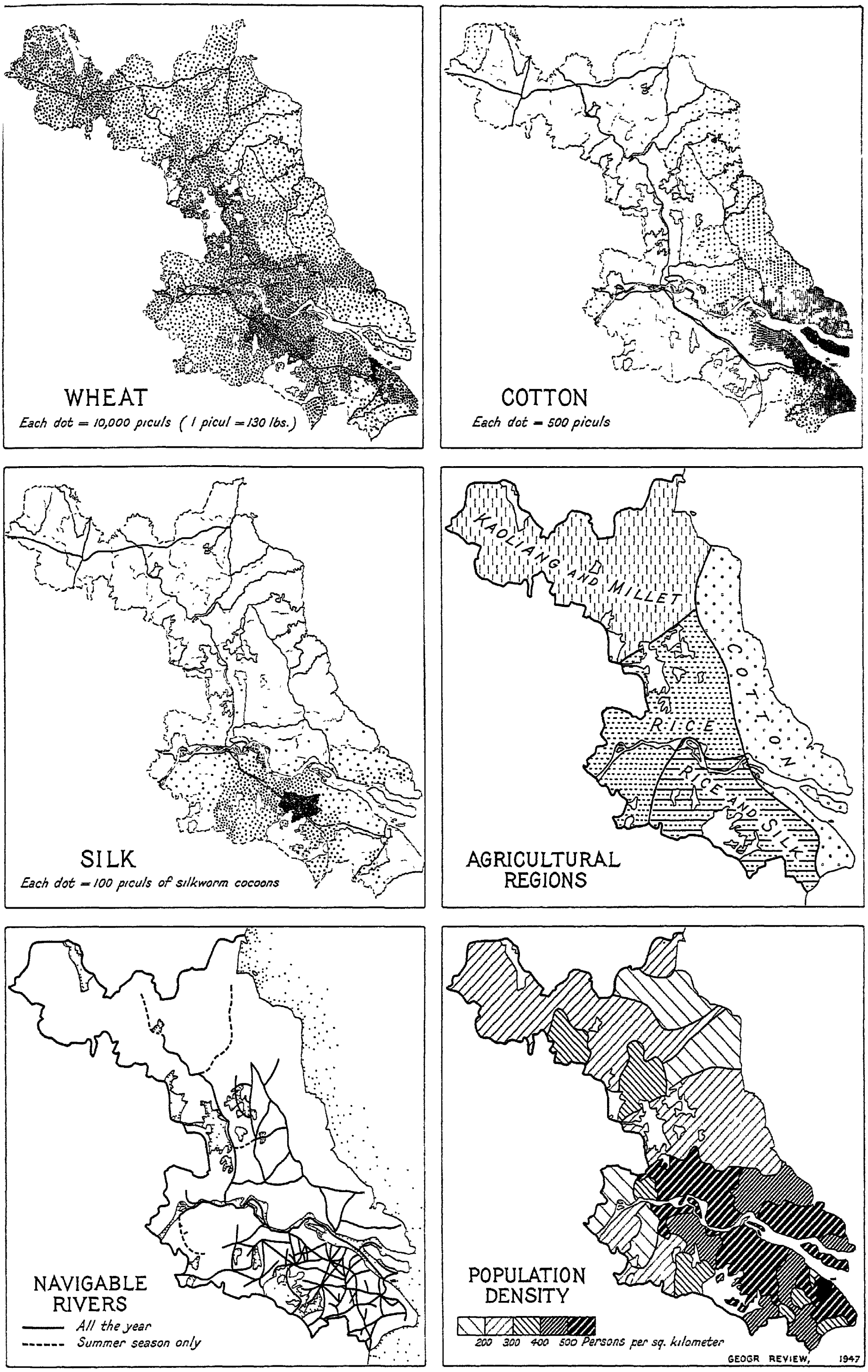


FIG. 3—Drainage conditions in central Kiangsu before the Hwang Ho was returned to its pre-1938 course in March, 1947.


118
120
122
34
32
600 mm.
700
800
900
1000
1100
0 50 MILES
0 50 KILOMETERS
ANNUAL RAINFALL
60
70
80
90
100
110
120
RAINY DAYS
NORTHERN
WESTERN
HSIA HO
COASTAL
NATURAL LEVEE
CHINHWAI HO
TAI HU
HYDROGRAPHICAL REGIONS
BROWN FOREST SOILS
CALCAREOUS ALLUVIUM
SALINE ALLUVIUM
NON CALCAREOUS ALLUVIUM
GRAY-BROWN FOREST CLAYPANS
SOILS
RICE
Each dot = 10,000 piculs (1 picul = 130 lbs.)
KAOLIANG
Each dot = 5000 piculs
GEOGR. REVIEW, 1947

FIGS. 4–9


WHEAT
Each dot = 10,000 piculs (1 picul = 130 lbs.)
COTTON
Each dot = 500 piculs
SILK
Each dot = 100 piculs of silkworm cocoons
KAOLIANG AND MILLET
COTTON
RICE
RICE AND SILK
AGRICULTURAL REGIONS
NAVIGABLE RIVERS
All the year
Summer season only
POPULATION DENSITY
200 300 400 500 Persons per sq. kilometer
GEOGR REVIEW, 1947

FIGS. 10–15

Kiangsu is just below the freezing point, a characteristic of the winter climate of North China.

Frost data show similar differences. At Shanghai the average date of the first frost is November 18, of the last April 3. Thus the frost-free season averages 228 days at Shanghai, 22 days longer than at Tungshan.

Hydrography and Floods

The Yangtze, the Hwai Ho, and the Hwang Ho, formerly independent rivers, were practically merged into a single system when the Hwang Ho was diverted southward in 1938.[1] In the low, flat plain, a difference of a few meters may be critical in furnishing immunity from the floodwaters of these rivers. About a century ago the Hwang Ho flowed into the sea by way of the lower Hwai Ho. When the lower channel became choked with silt, the Hwang Ho changed its course to the north of Shantung Peninsula. But the Hwai Ho could not now flow in its original channel because the river bed had been raised too high. It therefore used Hungtze Lake and a part of the Grand Canal as an exit to the lower Yangtze. Unfortunately, the flood season of the Yangtze coincides with that of the Hwai Ho, with the result that the latter becomes a river without outlet, and central Kiangsu forms the inevitable, though temporary, reservoir of its floodwaters. The situation became worse after the diversion.

In order to make this clear, it is necessary to give the heights of some important localities in central Kiangsu. The bed of Hungtze Lake is 10 meters above sea level, and the great Hungtze Dike guarding the southeast exit of this lake is 18 meters above sea level (Fig. 3). That part of the Grand Canal which takes the water of Hungtze Lake into the Yangtze is much lower than the lake. The bed of the Grand Canal is 3.8 meters above sea level, and the dike to its east is 8.5 meters above sea level. Farther east, the lowland of central Kiangsu is only 2 or 3 meters above sea level. The water level of the Hungtze may be 12 meters above the adjacent lowland, and even the high water of the Grand Canal may be 5 meters above it.

The maximum recorded discharge of the Hwai Ho is 15,000 cubic meters a second, but the ordinary maximum flow is between 3 and 5 thousand cubic meters a second. In normal years the Hwai Ho can easily discharge its water into the Yangtze by way of the Hungtze and the Grand Canal without doing any damage. But when the discharge is more than 8000 cubic meters, as it

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[1] The Yellow River was diverted at a point east of Changchow, Honan, in an effort to impede the Japanese invasion. Dr. Hu's manuscript was received before the work on the restoration of the river to its northward course had been completed; it has not been possible to submit proof to him.—Edit. Note.

is about every 5 years, the high water of the Yangtze will prevent its inflow, and the water impounded will break the canal dike and flood the lowland of central Kiangsu, known locally as the Hsia Ho region, which means "land below the river." The several small, shallow, low-lying streams in the Hsia Ho region cannot discharge the large quantity of floodwater. The situation is made even worse by the Fankung Ti dike, built in the seventh century for protection against the sea. Not only is the dike higher than the Hsia Ho lowland, but the coastal plain extending eastward from the dike is two or three meters higher than the inner plain. Both the dike and the outer coastal plain are effective in preventing the outflow of the floodwater and therefore prolong the period of inundation.

The abandoned channel of the lower Hwang Ho and Hwai Ho stands like a high ridge above the surrounding country. In fact, it functions as a dividing line between northern and central Kiangsu. Along the banks of the lower Yangtze are natural levees, which are higher than both the central and southern parts of the province. The northern levee further delimits central Kiangsu as a great depression, with the Hsia Ho region at the bottom.

The province of Kiangsu may be divided into seven hydrographic regions (Fig. 6):

1. Northern Kiangsu, subject to the floods of the Hwang Ho if it flows south by way of eastern Honan and western Shantung.
2. Western Kiangsu, subject to the floods of both the Hwai Ho and the Hwang Ho before the dike of the Grand Canal is broken.
3. The Hsia Ho region, subject to the floods of both the Hwai Ho and the Hwang Ho after the east dike of the Grand Canal is broken.
4. The coastal region, subject to the inflow of the sea water, a cause of damage to the cropland.
5. The natural levee of the Yangtze, free from flood because of the higher elevation.
6. The Chinhwai Ho Valley of southwestern Kiangsu, subject to the floods of both the Chinhwai Ho and the Yangtze.
7. The Tai Hu region, a low basin of southern Kiangsu, subject to the floods of Tai Lake.

Crops and Agricultural Regions

The monotonous Kiangsu plain produces a variety of crops. In the central and southern parts rice is the dominant food crop in the summer season (Fig. 8). The low flood plain, with its clayish soil and high summer temperatures, provides the ideal environment for rice. The northern limit is marked by the 800-millimeter isohyet. Millet and kaoliang are the important crops in northern Kiangsu (Fig. 9), where rainfall is smaller and the soil calcareous (Fig. 7). Although in Kiangsu there is no such effective barrier as the Tsingling Mountains, generally regarded as the dividing line in the west between North and South China, the change from rice to

millet and kaoliang is abrupt and clear-cut and can be explained only by the differences in rainfall and soil.

Winter wheat is planted throughout the province (Fig. 10). On the north bank of the Yangtze there is a strip of land on which millet, kaoliang, and peanuts are grown. Little rice is cultivated here because the land is slightly higher (10 meters above sea level) and irrigation is relatively difficult. Along the east coast the prevailing crop in the saline, sandy soil is cotton (Fig. 11). Around the Tai Hu basin mulberry growing prevails; here is the home of the famous Chinese silk (Fig. 12).

According to the distribution of crops Kiangsu has four main agricultural regions (Fig. 13): (1) millet and kaoliang in the north; (2) rice in the center; (3) rice and silk in the south; (4) cotton along the east coast.

Minerals

Alluvial plains are not generally endowed with mineral wealth. In the low hills on the northern and southern boundaries of the province some coal and iron are found, but the quantity is too small to be of much economic value. Limestone in the southern hills furnishes a good source material for cement.

Salt manufactured by evaporation of sea water is an important industry. The salt produced in northern Kiangsu is called Hwaipei salt; the annual production amounts to 200,000 tons. The people of the middle and lower Yangtze Valley depend on this supply, and the government has a monopoly on it. The salt produced in central Kiangsu, called Hwainan salt, has, however, declined in production. In salt manufacture the Hwai Ho again appears as a demarcation line; for to the north the salt is produced simply by solar evaporation, whereas to the south artificial heat has to be used to reduce the sea water, and the cost is therefore much higher than that of Hwaipei salt.

Navigable Waterways

"Boatman in the south, and horseman in the north" is an old Chinese saying. With respect to means of communication, the Hwai Ho has always been a line of demarcation. People had to leave their boats and ride on horseback or in carriages as they traveled from the south to the north. In southern Kiangsu waterways are numerous, especially in the Tai Hu basin; in central Kiangsu they are fewer; and in northern Kiangsu there are only two canals which are navigable in the summer season (Fig. 14).

The plain of Kiangsu may be monotonous, but such conspicuous differences between the north and the south are a significant geographical fact.

Population Density

As has already been pointed out, Kiangsu is one of the most densely populated regions in the world. The average density of 341 to a square kilometer (884 to a square mile) is higher than that of Belgium or the Netherlands (respectively 265 and 244 to a square kilometer in 1930). Population density is shown in Figure 15.

The southeastern part of the province, an intensively cultivated riceland, has the highest density, 500 to a square kilometer or 1280 to a square mile. The rather hilly southwest has a considerably lower density. In central Kiangsu, although the agricultural system is almost the same as in southern Kiangsu, the population density is much lower because of the frequent floods. In northern Kiangsu the average density is about 250 to a square kilometer or 640 to a square mile, a representative figure for the North China Plain, i.e. for the millet and kaoliang region.

Besides Shanghai and Nanking, which have urban populations of 3.6 million and 1.2 million respectively, there are ten cities with more than 100,000 population. Wuhsien (Soochow) has 263,000 inhabitants; other important cities are Wusih and Chinkiang in the south, Kiangtu (Yangchow) and Nantung in the center, and Tungshan (Suchow) and Hwaiyin in the north. All the important urban centers in southern Kiangsu are on the line of the Shanghai-Nanking Railway, whereas in the central and northern parts the distribution pattern of cities is rather spotty.

Economically, Kiangsu is the richest province of China. Besides the industrial and commercial activities of Shanghai and other cities, its agricultural importance is paramount. The ratio of cultivated land to total area is the highest (50 per cent) in all the provinces. Rice, cotton, and silk are the three principal agricultural products.

If the Hwai Ho and Hwang Ho floods can be brought under control, much of the idle land can be reclaimed, and the production of rice and wheat will be doubled. In the coastal region there are about 8 million mu (1.3 million acres) of land uncultivated because of soil salinity, which could become productive if adequately drained. These are the two foremost geographical problems in the postwar reconstruction of Kiangsu.

Within the Zion Hinterland there are a small number of automobile roads. In the south an improved road starting near La Verkin follows the canyon of the Virgin River eastward to Zion Park, then ascends the White Cliffs by means of switchbacks and tunnels (Fig. 1), and continues eastward to Mt. Carmel on U. S. Highway 89. A good mountain road crosses the southern part of the Markagunt Plateau connecting Cedar City with U. S. Highway 89 via Cedar Breaks. From this road can be seen the gypsum quarries and small coal mines opened in the Cretaceous strata near Cedar City; the beautiful canyon of Coal Creek, which anywhere else would be classed as a natural wonder; Cedar Breaks and Brian Head (Fig. 6); and recent lava flows near Navajo Lake and several older flows farther east. East of Navajo Lake the road crosses a barren volcanic area known locally as "The Desert." North of this road there are several Forest Service trails passable in good weather by ordinary vehicles, but local inquiry is advisable before they are used. South of about latitude 37° 30′ N. most of the trails are blind and lead only to isolated corrals, water holes, and mineral prospects. Extensive road and trail improvements in this area are now under consideration.

Weather and Climate

Weather data have been collected in this plateau region for several decades, by members of the various government services and by volunteer observers. The diligence, fidelity, and integrity of these volunteer observers are unquestionable, as is the validity of their observations for the specific areas in which they were made; and yet any regional summary based on their reports is likely to be sadly in error because of a multiplicity of factors here loosely called "terrain effects." The most important of these are "spotty" rainfall, local air circulations, and topographic modifications of incident solar radiation, such as local shading and local reflections, which may cause local temperatures to deviate by many degrees from the regional average.

If averages alone are considered, the temperatures of the Markagunt region are in general normal for its latitude, altitude, and distance from large bodies of water. In the higher parts winter lasts from sometime in October to sometime in May. Some snow is to be expected, but at least half of the days are clear and sunny. In the lower areas, such as the floor of Zion Canyon, winter conditions are of much shorter duration, outdoor work being possible, in most years, on all but a few days. Except for a few short cold spells, usually in January, winter temperatures seldom remain below zero for any great length of time. Summer maxima seldom exceed 110° F. for long; the few days of most intense heat occur usually in late

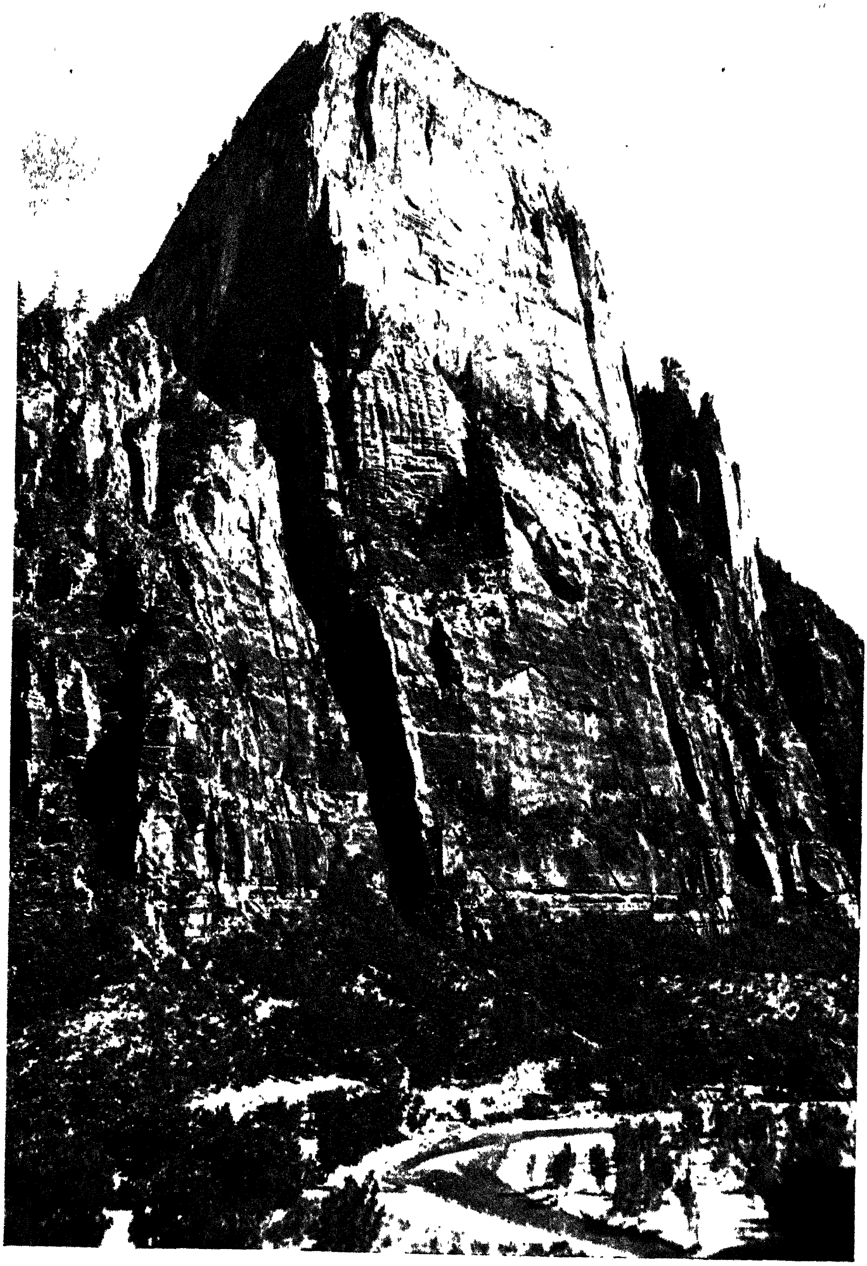


FIG. 3—The Great White Throne, in the upper part of Zion Canyon, rising more than 2000 feet above the valley floor. This monolith is composed almost entirely of Navajo sandstone. The summit (not visible in this view), however, is capped with Carmel limestone, and near the base the Kayenta formation can be seen, identifiable by the closer spacing of the bedding planes. Water seepage along these planes causes the Kayenta to weather back, and eventually large slabs of the unsupported sandstone break off. Cliff retreat caused by such basal sapping is going on throughout Zion Canyon. (Photograph from the Union Pacific Railroad.)

July and early August. Because of the low relative humidity, sensible temperatures are more moderate than absolute temperatures. Great diurnal temperature ranges are the rule in clear weather, caused in large part by the thin air of the high altitudes but also in part by local air circulations.

In most parts of the region there are two rainy seasons: the spring rains, usually fairly steady, in April, May, and the early part of June; and the rains of late summer and early fall, usually squally and erratic, in the latter part of July, most or all of August, and sometimes the early part of September.

Weather forecasting in the Zion Hinterland is rather difficult, particularly for relatively minor changes. The time of arrival of strong disturbances of large areal extent can be successfully predicted by the use of standard synoptic methods; but the local intensity and duration of the disturbance can be predicted only by correcting the synoptic forecast for local conditions, a difficult task at best, and one requiring a forecaster with long local experience. Summer squalls, usually of small areal extent and great local intensity, cannot be forecast with any accuracy. Modern instruments and methods indicate only the probability of a squall somewhere in the vicinity. When the squall has actually begun, however, its probable trajectory can be predicted, usually with considerable accuracy, by an experienced local observer. Many of the veteran government field workers in this region have acquired great skill in this type of forecasting.

Flora and Fauna

Distribution of vegetation in the Zion Hinterland offers complex and interesting ecologic problems that are only partly solved at present. In a very general way, the lower areas are characterized by a semidesert assemblage of stunted trees and shrubs (Upper Sonoran flora), and at altitudes above 7000–9000 feet, depending on local conditions, the flat areas are occupied by an open forest of yellow and lodgepole pines, Engelmann spruce, aspen, and occasional cottonwoods (Fig. 5). Because of the marked local variations in climate, there are also many variations in vegetation within the altitudinal zones. As a result, "islands" of the different types of vegetation may be found at elevations higher or lower than their characteristic positions. In addition, wherever the land surface is bare rock or is indurated into caliche, a barren island occurs in the local vegetal cover. A few grassy meadows are present in the forested areas, where low places are poorly drained or where the soil chemistry is unfavorable for trees.

Animal life in the region is not stabilized at present, because of recent extermination of most of the larger carnivores and diligent protection of

the larger herbivores. Mule deer are fairly numerous in all parts of the plateau and are so tame as to be a nuisance at times. During the author's reconnaissance of the region one bighorn was seen near the head of Orderville Gulch, and tracks indicated that there might have been as many as six of them there. Tracks of bear, bobcat, and mountain lion were seen, north of Cedar Breaks. Badger, porcupine, and many varieties of smaller rodents are rather numerous. Lizards of several kinds, including some rare varieties, are said to be common. Contrary to most local reports, rattlesnakes are apparently not common in the plateau region: only one was seen during the progress of the field work. Birds of the higher parts of the plateau are types to be expected in wetter mountain areas farther north; those seen in the lower areas were, in general, desert types. Modifications of the behavior of the more intelligent animals in the vicinity of man and his culture present an interesting field of study, which, unfortunately, is beyond the scope of this report.

Physiographic Description

After the preliminary reconnaissances of Major John Wesley Powell, who visited what is now Zion National Park on September 12, 1870,[4] the geology and physiography of the Virgin River headwaters area were outlined by G. K. Gilbert[5] and C. E. Dutton.[6] More recently, detailed investigations by H. E. Gregory and others have extended and refined the data from the earlier explorations and have related the stratigraphy of the Zion Hinterland to the regional picture.[7]

The Zion Hinterland as here defined is roughly rectangular in outline,

[4] J. W. Powell: Canyons of the Colorado, Meadville, Pa., 1895, pp. 295–296.

[5] G. K. Gilbert: Report on the Geology of Portions of Nevada, Utah, California, and Arizona, *in* Report upon United States Geographical [and Geological Explorations and] Surveys West of the One Hundredth Meridian [Wheeler Surveys], Vol. 3, Geology, Engineer Dept., U. S. Army, Washington, 1875, pp. 17–187, reference on pp. 78–79.

[6] *Op. cit.*, pp. 26–60, Plates 4–13, and Atlas Sheet 4. In this report Dutton describes some of the scenic features of the Zion Hinterland region. He had already carefully "blocked out" the regional relationships of the plateau area of Utah in a still earlier report (Report on the Geology of the High Plateaus of Utah [with atlas, 1879], U. S. Geographical and Geological Survey of the Rocky Mountain Region, Washington, 1880).

[7] H. E. Gregory: Geology of the Navajo Country, *U. S. Geol. Survey Professional Paper 93*, 1917; *idem:* Colorado Plateau Region, *Internatl. Geol. Congr., 16th Sess., United States, 1933, Guidebook 18*, Washington, 1932; *idem:* A Geologic and Geographic Sketch of Zion National Park, *Zion-Bryce Museum Bull. 3*, 1939; *idem:* Geologic Observations in the Upper Sevier River Valley, Utah, *Amer. Journ. of Sci.*, Vol. 242, 1944, pp. 577–606; *idem:* Geology of the Eastern Markagunt Plateau, Utah (abstract), *Bull. Geol. Soc. of America*, Vol. 57, 1946, p. 1253; H. E. Gregory and N. C. Williams: Zion National Monument, Utah, *ibid.*, Vol. 58, 1947, pp. 211–244. A thorough description of the geology of this region, by H. E. Gregory, will appear shortly as a *Professional Paper* of the U. S. Geological Survey. Publication of this work, completed in 1939, has been delayed by the war.

FIG. 4—The Great Arch of Zion, as seen from a window in one of the tunnels of the Zion—Mt. Carmel Highway. Embrasures of this type are common in the Navajo sandstone.

FIG. 5—Open forest south of Cedar Breaks, on thick soil of the Kolob Meadows derived from Cretaceous sandstones. The channel in the left foreground is the head of Deep Creek.

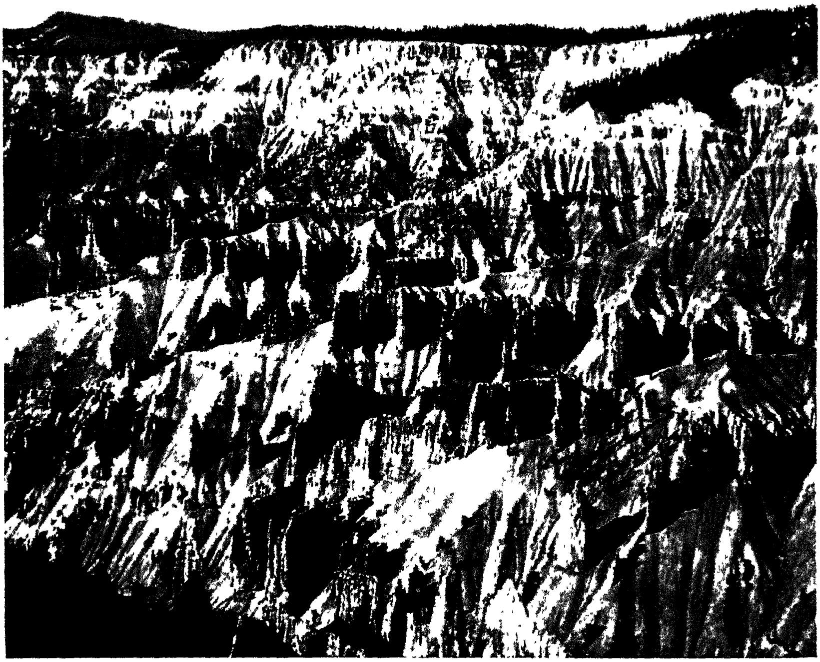


FIG. 6—View northward from the south rim of Cedar Breaks, showing the residual pillars within the amphitheater, the general summit level above the Pink Cliffs (middle distance), and Brian Head (horizon, left). (Photograph from the National Park Service.)

FIG. 7—Solution cavity in Upper Cretaceous limestone.

about 40 miles wide and 50 miles long, the longer axis trending approximately 20° east of north. It is part of an uplifted sedimentary fault block bounded on the east by the Sevier fault and on the west by the Hurricane fault. Differential erosion of the thick mass of sedimentary rocks that make up this block (Fig. 8) has produced a series of great rock terraces that ascend northward to an upland more than 10,000 feet above sea level. Latitude 38° N., on this upland, has been chosen as the northern boundary of the region. The steep cliffs, hundreds of feet in height, that bound each terrace step are, from the base up, the Vermilion, the White, and the Pink Cliffs (Fig. 1). In the area between Cedar Breaks and Navajo Lake the White and Pink Cliffs are replaced near major drainages by sloping rock surfaces covered with thin soil.

A good understanding of the physiographic features of the Zion Hinterland and of their relations to the regional stratigraphy can be obtained from examination of a northeast-southwest section (Fig. 2) from the upland north of the Pink Cliffs to the junction of the Forks of the Virgin River.

Markagunt Meadows. Extending northward with few breaks from the Pink Cliffs toward the rather indefinite northern margin of the Markagunt Plateau is the surface here called the Markagunt Meadows. Soils produced by the decay of Wasatch and Brian Head beds (Fig. 8), slightly modified by feeble Pleistocene glaciation and solifluction and by localized ash falls, support an open forest and meadow vegetation. Rising above the upland surface is Brian Head (Fig. 6), a little more than 11,000 feet high, and incised into its western margin by Coal Creek is Cedar Breaks, an erosional amphitheater. At this level are found small areas of old, decayed lavas, mostly rhyolite and trachyte, and of younger basalts, notably those that impound the waters of Navajo Lake and those farther east in "The Desert." There are several sinkholes in the Markagunt Meadows, and subsurface channels from them to solution cavities at lower levels (Fig. 7) are assumed.

Kolob Meadows. Below the Pink Cliffs and extending south to and just beyond the large basalt flows at 37° 28′ N. (Figs. 2 and 11) are the Kolob Meadows, roughly coextensive with the Kolob Terrace. A few small pinnacles and spires, the result of differential erosion, rise above the surface. This area is composed largely of weathered Cretaceous rocks and is covered with open forest (Fig. 5) and lush grasslands except in a few depressions where acid seepage water from oxidizing coal beds inhibits plant growth. Sinkholes were not found here, but ponded water is notably absent in depressions, even after moderately heavy rains, an indication that much of the drainage is underground.

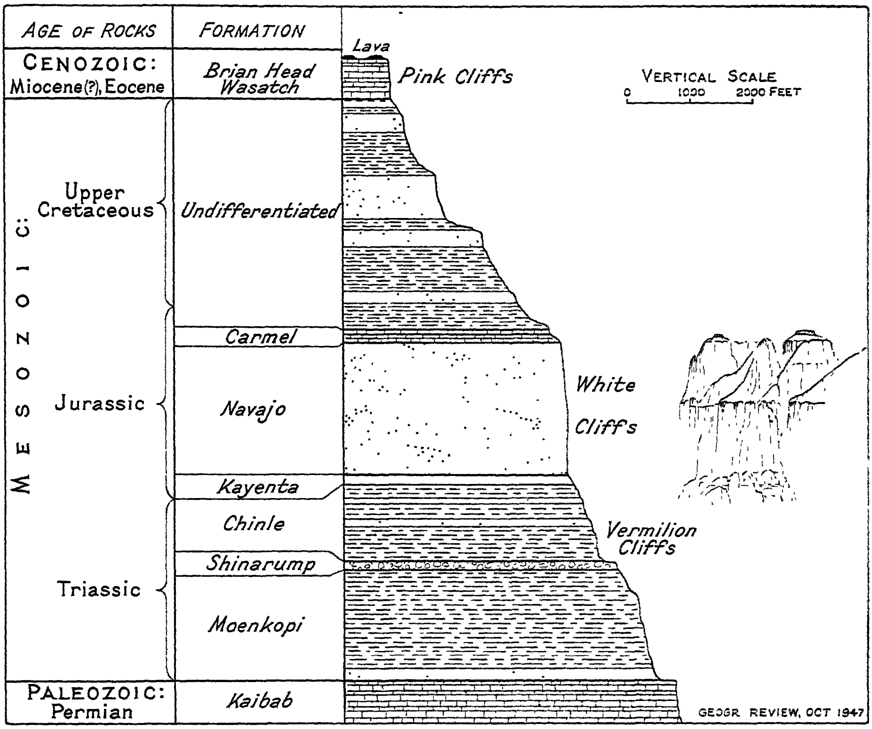


FIG. 8—Summary of the stratigraphy of the Zion Hinterland, showing relative thicknesses of the formations and their characteristic cliff profiles. Modified from a figure drawn by H. E. Gregory for the National Park Service. During the author's field study, exposures in the interior of the plateau were checked against this section, and all deviations from it were found to be minor and geologically insignificant.

Many of the deep and spectacular canyons of the Zion Hinterland begin in the Kolob Meadows, but here their depths are usually not great, ranging from a few inches near the Pink Cliffs (Fig. 5) to a few hundred feet near the southern margin (Figs. 2 and 9). On the canyon walls water seepages along some of the bedding planes support dense growths of brush (Fig. 11), which, because of the approximately horizontal structure, form parallel horizontal bands of intensely green vegetation along the yellow and gray canyon walls. This arrangement of the vegetation is well described as "Hanging Gardens," a term that has been applied also to parts of The Narrows.

The southern part of the Kolob Meadows is covered by extensive thick basalt flows, into which the larger streams have cut (Fig. 10). The flows, attributed to fissure eruptions because no cones or traces of them have been found, are tentatively dated as Pliocene, and it is evident that they antedate the canyons. Both walls of most of the canyons are capped by identical

FIG. 9—View southward in the canyon of Deep Creek. in the Kolob Meadows, 37° 32′ N. (see Fig. 2). The canyon here is cut in Upper Cretaceous strata. The stream has a steep gradient and flows on bedrock in most places.

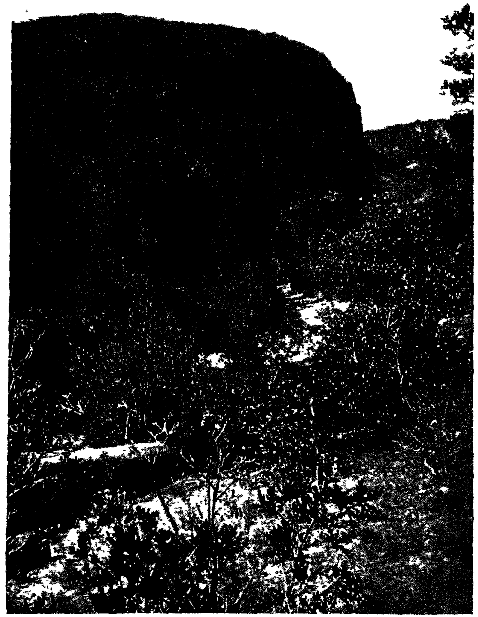


FIG. 10—View downstream in the Kolob Meadows, 37° 29′ N. Typical columnar structure in the thick basalt flow. The stream has a slight gradient and flows on thick valley fill and disintegrated Cretaceous material.

FIG. 11—Basaltic cliff atop Cretaceous sandy limeston 37° 28′ N., and talus of basalt fragments. Here most of th water of Deep Creek flows through and under the extensiv interfingered talus cones.

basalts, of the same thicknesses, at the same levels, and with vertical joints. Had the lava flowed into the canyons, the joints would be at right angles to the canyon walls, "drip" structure might be present in places, and the lava in the canyons would be a large mass of flow breccia, relatively intact because of its great resistance to weathering and erosion. Instead, the lava found in the canyons is normal fragmentary talus (Fig. 11), which definitely parted from the main mass along the vertical cooling cracks.

For several miles the floors and walls of the canyons are covered with this basaltic talus, through and under which most of the stream flows. In consequence, the exact level of the bedrock canyon floors and the exact stratigraphy of the lower parts of the walls cannot be determined by direct inspection. In Figure 2 the valley floor is close to bedrock except between latitudes 37° 25′ and 37° 31½′ N. The location of the concealed floor is inferred from conservative extrapolation of the stream profile, checked against comparable profiles in adjacent canyons. Valley-wall stratigraphy in this zone was inferred from a linear extrapolation of the dip of exposed beds, a procedure that leaves much to be desired, since an increase in the regional northward dip takes place somewhere in this vicinity.

Deep Creek Canyon. Southward from about 37° 28′ N. to its junction with the North Fork the valley of Deep Creek is a chaotic defile resembling in cross section a large U trenched by a small V-shaped notch (Fig. 17 B). The main walls of the canyon consist of undifferentiated Jurassic and Upper Cretaceous strata, capped in some places by lava. Beneath these the weaker Carmel limestone outcrops, and the slopes are gentler, forming the bottom of the U. The V-shaped inner gorge (Fig. 12) is carved in Navajo sandstone.

The Junction Area. At the junction area of Deep Creek, Kolob Creek, and the North Fork of the Virgin River, and separating the Deep Creek canyon from The Narrows of the North Fork, there is an elongated amphitheater floored with stream gravel, flood deposits, and landslip debris. Although the canyon walls here, being of solid rock, remain largely unchanged from season to season, the floor details are markedly altered after each interval of high water, so that where firm footing was found in one season, there may be a bed of quicksand in the next.

The Narrows. Downstream from the junction area (37° 21′ N.; see Fig. 2) the combined waters of Kolob Creek, Deep Creek, and the North Fork flow through The Narrows. This canyon, one of the most spectacular gorges in the world, was first seen by G. K. Gilbert,[8] about 1872. Its charac-

[8] *Loc. cit.* From Gilbert's description it is apparent that he traversed the North Fork canyon from the head of The Narrows, where the North Fork first penetrates the Navajo sandstone, to and through Zion Canyon. The basalt stream boulders he describes were washed down by Deep Creek from the southern margin of the Kolob Meadows.

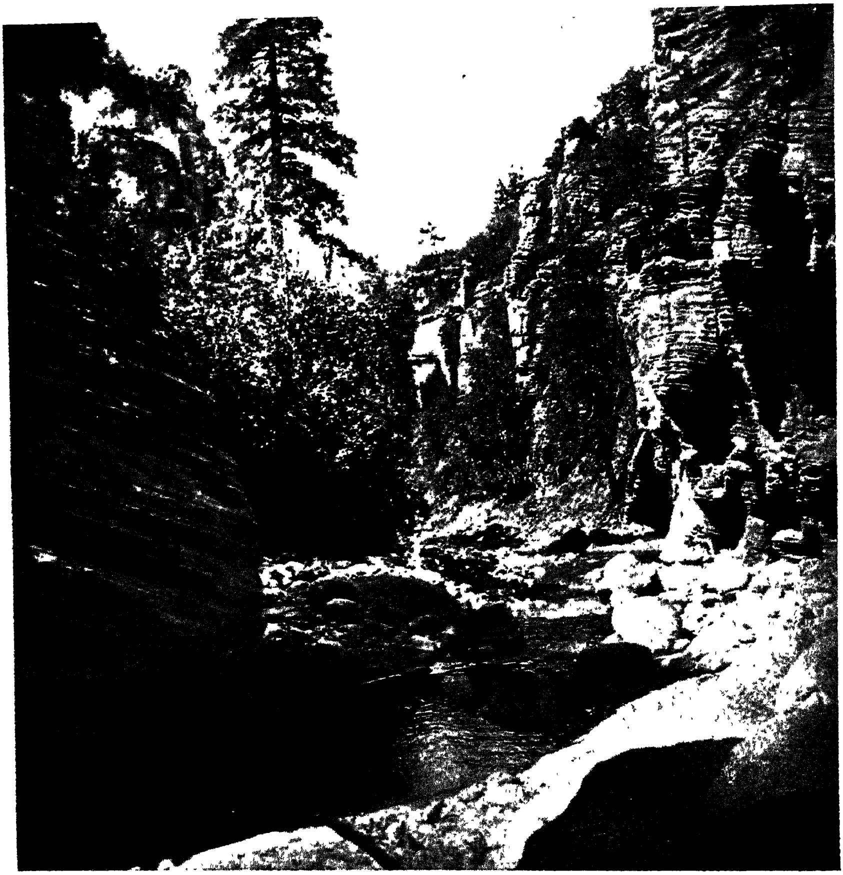
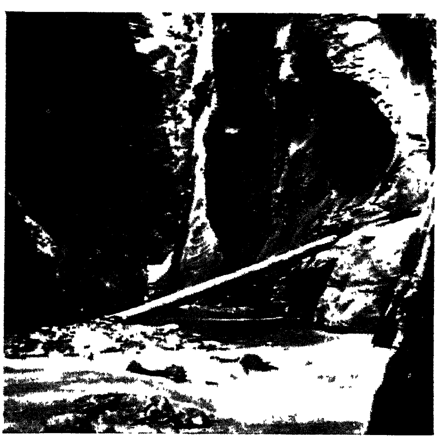


FIG. 12—Scene in the inner gorge of Deep Creek canyon (37° 23′ N.). The wall rock is Navajo sandstone, and the bedding is typical of the upper part of this formation. Many of the stream boulders are rounded basalt fragments from the lavas seen in Figures 10 and 11.

FIG. 13—Rockfall in The Narrows. The large fallen block in the center is approximately 4 by 4 by 5 feet. The canyon wall shows typical eolian cross-bedding on the left

FIG. 14—Brightly lighted section of The Narrows. A small spring high on the canyon wall (upper right) supports a growth of brush and ferns. Note the characteristic bedding of the Navajo sandstone and the "slabbing off" of a thin sheet of rock on the upper left.



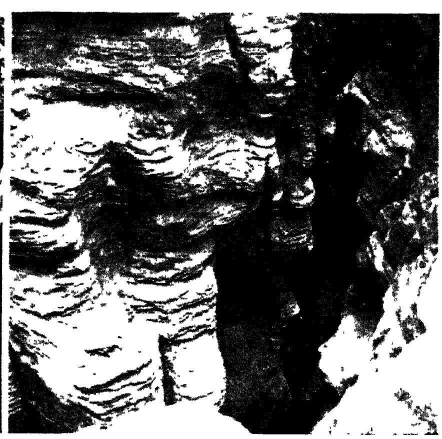


FIG. 15 (left)—Bottom of The Narrows. Here the canyon is about 30 feet wide at the bottom, slightly less than 2000 feet deep, and in places about 1000 feet wide at the top.

FIG. 16 (right)—Small tributary canyon produced by erosion along a joint in the Navajo sandstone. Such canyons may be two feet wide and 200 feet deep.

teristic features are the great depth relative to the width (Fig. 17 C) and the sinuosity of the stream course. In this general vicinity the whole terrain is carved into a labyrinth of similar tortuous "slot" canyons, some of which hang above the main canyons. Overhanging walls hide the sky from the bottom of The Narrows in many places. A typical view in these deep parts is seen in Figure 15, which, although taken about noon on a sunny July day, had to be a time exposure.

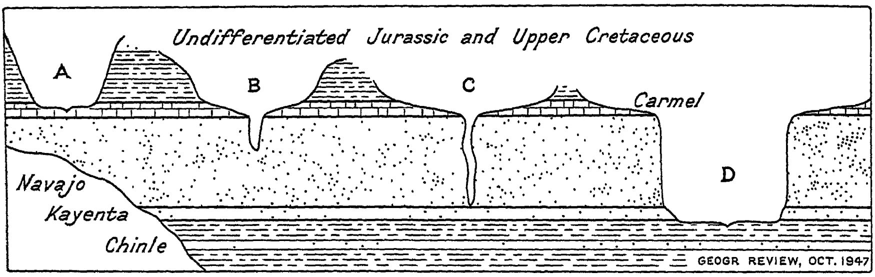


FIG. 17—Diagrammatic section illustrating different types of canyon cross profiles. A is typical of the larger canyons in the Kolob Meadows. B is found in Deep Creek canyon and in comparable parts of Orderville Canyon and the valleys of the North Fork and Kolob Creek. C is typical of The Narrows and of parts of Parunuweap Canyon. D is typical of the North Fork of the Virgin River (Zion Canyon).

Where the canyon is open to the sky, grass, brush, and ferns grow on every moist ledge (the "Hanging Gardens" of The Narrows), particularly where small channels in the sandstone allow subsurface waters to escape as springs into the main canyon (Fig. 14). Such springs, emitting considerable volumes of water, are especially numerous in the lower part of the Navajo sandstone. They flow from conglomeratic members of the formation or from small solution cavities, probably formerly occupied by calcareous "runners" in the sandstone, and are commonly surrounded by thick deposits of algal tufa. Several of the springs roar or make other noises.

Rockfalls are common in The Narrows, particularly near canyon-wall springs. Rockfall debris may change the stream profile markedly, but as a rule the next season's floods restore the previous gradient. One such rockfall, shown in Figure 13, apparently had occurred shortly before the photograph was taken, since some of the fragments were still coated with rock dust.

Sinuosity of the stream channel, which is considerable everywhere, is extreme in The Narrows. The air-line distance from the junction of the North and East Forks of the Virgin to Cedar Breaks (Fig. 1, section course) is about 36 miles; the trail distance, following the stream channel, is nearly 57 miles. In The Narrows, for which previous surveys had supplied dependable index points, the following measurements were made in the reach

of canyon between $37^\circ\ 18'\ 30''$ and $37^\circ 19' 30''$N. (Fig. 18): air-line distance, 6700 feet; length of channel, 15,750 feet; stream distance, 20,525 feet; trail distance, 23,000 feet.

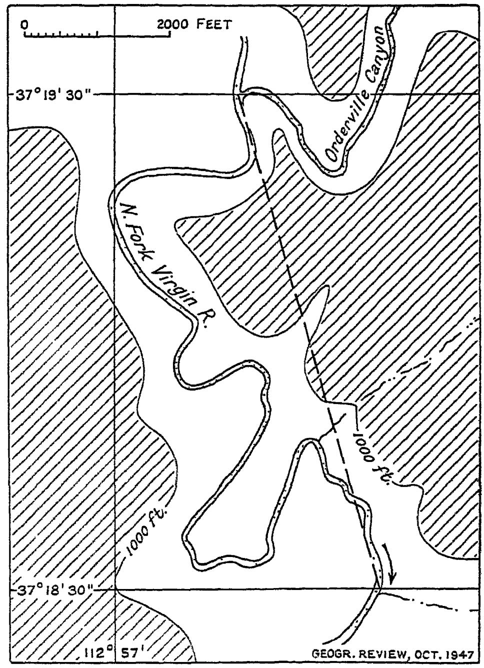


FIG. 18—Course of the North Fork of the Virgin River through one minute of latitude as determined from the author's field surveys and from photographs and official maps. The broken line indicates the air distance. Areas more than 1000 feet above the stream bed are cross-hatched.

In The Narrows the stream does not flow directly on bedrock, but on a coarse gravel fill containing many large stream boulders. This material does not appreciably prevent downward cutting, for each flood turns it over and removes the "fines." In natural consequence, the locations of the fords, quicksands, and "holes" are not fixed, and a new trail must, in general, be hunted each time the canyon is traversed. A part of the flow of the North Fork, in many places, goes under and through this valley fill. The subsurface flow sometimes undermines the surface, producing areas of bad footing. Some increase of the stream flow, both surface and subsurface, from springs in the canyon floor is suspected.

Zion Canyon. Where the North Fork cuts through the Navajo sandstone and into the weaker Kayenta formation below it (about $37^\circ\ 17'$ N.), numerous seepage springs at the contact undermine the steep sandstone cliffs and cause them to recede. As a result, the canyon is about as wide as it is deep, and its cross profile resembles D in Figure 17. This physiographic division, Zion Canyon, is the best-known part of Zion National Park. It has been adequately described in many publications since 1872. One of its most impressive features is the sandstone monolith known as the Great White Throne (Fig. 3), before which, according to local legends, "Mormon sinners and Gentile saints" will some day stand for final judgment.[9]

[9] Teachers of geography will find comparison of a photograph of the Great White Throne from Observation Point (such as Union Pacific Photograph 13,642) with the appropriate part of the topographic map of Zion National Park a fine illustration for a map-reading course.

The physiographic history of the Zion Hinterland begins with the elevation, in early Tertiary time, of the entire Colorado Plateau region from sea level to more than 4000 feet above it. Subsequent events include the outpourings of the various lavas, the elevation of the Zion Hinterland fault block an additional 6000 feet or more, and the dissection of this upraised block by streams into its present labyrinthine form.

In early Eocene time the region was the floor of a shallow sea. It rose slightly during the lower Eocene; for the Eocene deposits, which now form the Pink Cliffs (Fig. 6), are marine limestones at the base and fresh-water sediments above.

After the close of the lower Eocene, intermittent deposition of fresh-water and dry-land deposits continued until the Miocene(?), when rather widespread volcanic activity resulted in deposits of fragmentary volcanic materials (the upper part of the Brian Head formation, present in the Markagunt Meadows section), most of which were covered by thick flows of rhyolite and trachyte. This same early-Tertiary sequence of deposits covers the Paunsaugunt Plateau, east of the Markagunt; and nearly identical sequences are found on the lower lands west of the Hurricane fault, at elevations of not much more than 4000 feet. This indicates that the plateaus were at the same level as the lowlands when the lavas were extruded, an occurrence tentatively placed in the Miocene by Gregory,[10] and that the block between the Hurricane and Sevier faults did not become a separate physiographic entity until later.

It should be specifically noted that the early lavas are present as flows, and that the volcanic interval may have lasted tens or even hundreds of thousands of years, with some or many quiet interludes, of which most of the evidence has been buried by later flows or eroded away.

After, but probably not long after, the close of the volcanic interval that produced the rhyolite and trachyte caps on the plateau and adjacent areas, local drainages, tributary to the Colorado River, were established,[11] and the region as a whole was slowly uplifted. As a result, the larger part of the lavas, most of the Miocene(?), much of the Eocene, and part of the Cretaceous sediments were removed by erosion (roughly the equivalent of the "Great Denudation" of Dutton[12]). Since uplift probably did not proceed at a

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[10] Geologic Observations in the Upper Sevier River Valley, Utah, pp. 595–605.

[11] Evidence recently summarized by C. R. Longwell (How Old Is the Colorado River? *Amer. Journ of Sci.*, Vol. 244, 1946, pp. 817–835) indicates that the Colorado River was established not later than the early Pliocene and not earlier than the late Miocene.

[12] Tertiary History of the Grand Cañon District, pp. 61–76.

uniform rate, it is likely that the erosion was accomplished in a series of cycles, some of which may have advanced to old age before they were interrupted by renewed uplift. In the Zion National Park area, for example, the upland surface (Valley Rim surface, Fig. 2), an extensive, fairly level area about 7000 feet above sea level, truncates the slightly inclined Jurassic and Upper Cretaceous strata and is covered with a fairly thick and fertile residual soil. It is interpreted by the author as a peneplain remnant.[13] Some of the numerous buttes and mesas that rise above it may be remnants of still earlier peneplains. However, because of the nearly horizontal structure of the region and the alternation of weak and resistant formations, structural control is prominent in most places, and these features cannot be accepted as undisputed evidence of former peneplains.

Upon the Valley Rim surface basalts (the older basalt series of the region) poured out, probably from fissures, filling many of the surface depressions and armoring large areas, so that erosion by any but major streams was impossible. To judge by their appearance, these basalts are definitely older than those near Fillmore, Utah, dated by Gilbert as Pleistocene, but they are certainly no older than the basalts at Fumarole Butte, northwest of Sevier Lake, which he dated as Tertiary.[14] They are probably Pliocene.

Because these lavas, where they cross the Hurricane fault (Fig. 1), are displaced less than those of the first series (largely rhyolites), it is concluded that part of the elevation of the area east of the Hurricane fault relative to the western lowlands took place before the extrusion of the Pliocene(?) basalts.[15] Differential movement along the Sevier fault at about this time separated the Paunsaugunt Plateau, to the east, from the present Markagunt Plateau.

Materials eroded from the summit and flanks of the Markagunt Plateau and the rock terraces to the south by the Virgin and its tributaries and by

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[13] It should be noted that for adjacent parts of the Colorado Plateaus province several recent papers (see, for example, A. N. Strahler: Valleys and Parks of the Kaibab and Coconino Plateaus, Arizona, *Journ. of Geol.*, Vol. 52, 1944, pp. 361–387; E. D. Koons: Geology of the Uinkaret Plateau, Northern Arizona, *Bull. Geol. Soc. of America*, Vol. 56, 1945, pp. 151–180) have suggested the possibility of a slow continuous uplift, or a succession of uplifts with pauses too short to permit peneplanation. According to this hypothesis, the erosion of the region was accomplished in a single cycle, and remnants of erosion surfaces are interpreted as remnants of pediments, which have no cyclic significance.

[14] G. K. Gilbert: Lake Bonneville, *U. S. Geol. Survey Monograph No. 1*, 1890, pp. 319–320 and 323 and pp. 332–335 respectively.

[15] Ellsworth Huntington and J. W. Goldthwait: The Hurricane Fault in the Toquerville District, Utah, *Bull. Museum of Comp. Zoöl. at Harvard College*, Vol. 42 (Geol. Ser., Vol. 6), 1903–1905, pp. 197–259; Gregory and Williams, *op. cit.* The rhyolites and trachytes contained in, and associated with, the Brian Head formation are displaced more than 5000 feet relative to their exact counterparts just west of the Hurricane fault. Displacement of basalts in the same area is only 800 to 1600 feet. That is, displacement of 3400 to 4200 feet occurred before the basalt outpourings.

various other members of the Colorado River system were carried completely out of the plateau region and were, in all probability, deposited as fill in the ancient delta of the Colorado, which now separates the Imperial Valley from the Gulf of California. Alluvium washed northward by the Sevier River and its tributaries is found in a few locations as valley fill and constitutes, at least in part, the Sevier River formation, dated by Gregory as Pliocene(?).[16]

Differential uplift of the plateau with respect to the western lowlands, resumed soon after the Pliocene(?) basalt outpourings, eventually raised the summit of the uplifted block more than 6000 feet above the lowlands. That this uplift may have continued until relatively recently is suggested by the warping of the ancient shore lines of Lake Bonneville, first noted and explained by Gilbert. Because the uplift has been too rapid for erosion to keep pace with it, the plateau is a topographic high. The streams, of which Deep Creek (roughly parallel to the section course in Fig. 1) is typical, have been incised into the Valley Rim surface and the basalts upon it.

During this erosion interval the major streams on the plateau have acquired new small tributaries, the courses of which are determined by local and recently exposed rock features, usually joints. Most of the smaller tributaries to the Virgin in The Narrows and Zion Canyon originated in this manner. One such eroded oint, now a stream channel, is shown in Figure 16.

Because of the latitude, the summit of the Markagunt Plateau was not intensely glaciated at any time during the Pleistocene, but a considerable amount of scattered evidence indicates the presence, at least once in that epoch, of a thin, slowly moving icecap on the plateau and the former occurrence of solifluction on the level parts of the south and east flanks. Increased rainfall during parts of the Pleistocene contributed to the vigorous erosion of the region after its uplift.

Very recently, geologically speaking, and not very long ago in human history, relatively feeble volcanoes erupted in many parts of the Markagunt Plateau and adjacent regions, producing lava flows, vents, and cones, which still retain their minor surface features. The flow near Navajo Lake (Fig. 1) is typical of this sequence, and the more extensive but less accessible series of cones, craters, and flows near Firepit Knoll (Zion National Monument)[17] also date from this later volcanic outbreak. By their appearance these basalts are judged to be younger than the Pleistocene basalts near Fillmore, Utah,[18]

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[16] Geologic Observations in the Upper Sevier River Valley, Utah, p. 597.

[17] Gregory and Williams, *op. cit.*

[18] Gilbert, Lake Bonneville, pp. 319–320 and 323.

and approximately contemporaneous with the lavas at Sunset Crater, near Flagstaff, Arizona, which were extruded during the Christian Era.[19]

A few of the valley fills peripheral to the Markagunt were still untrenched in the 1870's, when the first thorough explorations of the area were made, but have since been deeply incised. This new cycle of erosion, begun in the latter half of the nineteenth century, may indicate a very minor climatic change, or it may be the result of overgrazing.[20]

Evidences of Early Occupation

Upstream from Zion Canyon, where several small cliff houses have been found, evidences of early human occupation are slight and inconclusive. The only finds made during the course of this investigation were a few old fireplaces in natural rock shelters in Deep Creek Canyon and a few chips of worked flint and obsidian in the Markagunt Meadows.

Occupation by white men before about 1900 was likewise not extensive and is poorly documented. Ruins of a few miners' cabins, identified by ore samples, tobacco tins, and empty bottles, were found at several water holes. Near the ruins of one cabin in the Kolob Meadows were found the remains of a hoopskirt and several slippers (one carefully cut out to relieve a bunion), indicating that at least one woman lived in the area as early as about 1870.

Although several legends heard in the vicinity of Cedar City told of a Mormon bishop who fled to the plateau with his harem after a difference of opinion with his ecclesiastical superiors and there established a colony that still exists, no evidence of the present or former existence of such a colony was found in the field, and no historical record of such an occurrence could be found in the Mormon historical files in Salt Lake City. The legend seems to be a good example of the Western "tall story."

Economic Factors

Although the tourist industry is commonly regarded as the main support of the Zion Hinterland and the towns on its margins, the most important product of the region, in all probability, is the water that flows from it. This is used for irrigation in the lowlands to the southwest (Utah's "Dixie") and makes possible farming in an area that would otherwise be desert.

[19] The date of the Sunset Crater eruption is now placed in the eleventh century of our era. See the note by Harold S. Colton, "A Revised Date for Sunset Crater," *Geogr. Rev.*, Vol. 37, 1947, pp. 144–145. Another flow that appears to be of about this same age, at McCartys, N. Mex., overlies valley fill containing potsherds and was probably extruded about A.D. 1000. See R. L. Nichols: McCartys Basalt Flow, Valencia County, New Mexico, *Bull. Geol. Soc. of America*, Vol. 57, 1946, pp. 1049–1086.

[20] R. W. Bailey: Epicycles of Erosion in the Valleys of the Colorado Plateau Province, *Journ. of Geol.*, Vol. 43, 1935, pp. 337–355.

The higher parts of the Markagunt, now administered by the United States Forest Service, are used as summer rangelands. At present, the high meadows and open forests seem to be undergrazed, probably because of the prohibitive cost of fencing the areas adjoining the deep canyons. Timber resources appear adequate for local mining and construction use but not for a large "export" industry. Expansion of lumbering is probably not desirable, since the forest cover is more valuable as watershed protection than as lumber.

Mineral resources include coal, gypsum, gravel, sand, limestone, and shale, and a variety of commercially unworkable minerals that have a small value as specimens and curiosities.

The coal, of Colorado (Upper Cretaceous) age, ranges from low-grade bituminous to subbituminous and includes some cannel. It is not good for metallurgical uses because it is sulphurous and of poor coking quality, but it is usable as stove and boiler coal. The reserves are sufficient for local heating and power for many generations to come.

Gypsum deposits, also of Upper Cretaceous age, are exposed in Coal Creek Canyon, not far from Cedar City. They have been worked intermittently on a small scale and have considerable potential value, but lack of capital has prevented their full development.

Gravel and sand are worked for local use and are present in adequate quantity for any foreseeable local need. Export is not profitable. The possibility that a cement industry might be established using local coal, limestone, and shale has been discussed for at least two decades. Although such a development seems economically practicable, present cement manufacture in the area does not even fill local needs.

In areas where petrified wood weathers out of the Shinarump and Chinle formations, small-scale polishing and fabrication of petrified-wood products has been carried on. This, and the collecting of geodes, pyrite balls, giant selenite crystals, and similar mineral specimens, has been fairly profitable for a few highly skilled individuals, but large-scale development seems to be precluded by a saturable market.

The economic outlook for the Zion Hinterland appears promising, provided full use is made of local resources. Construction of a few miles of access road, so that the head of The Narrows could be reached from upstream, and some improvement of road facilities in Zion National Monument would stimulate the tourist industry. Additional use of the mineral resources awaits capitalization sufficient to permit large-scale or continuous production. A part of the unfavorable economic effect of geographical isolation might be offset by the shipment of refined mineral products.

THE NORTHERN ALASKAN COASTAL PLAIN INTERPRETED FROM AERIAL PHOTOGRAPHS

EDWARD C. CABOT

THE northern Alaskan coastal region, almost untraversable, has seldom been visited, and its exploration has been practically confined to the river valleys. Recently, however, aerial photography has made possible the first complete mapping of this region[1] and provided a perspective, heretofore lacking, of its physiography. The area here under discussion lies between the Arctic Sea and the Brooks Mountains—about 140 miles—from the Canning River westward. It can be divided into two physiographic provinces: a dissected upland and an alluvial plain. In an abrupt change reminiscent of our West the steep, maturely eroded front of the Brooks Range gives way to the upland. The upland, about 50 miles broad with a grade of 1000 feet, is actually a pediment cut on uplifted sedimentary beds (Fig. 3). It was built up from detritus deposited by the mountain streams, and it is now dissected into a youthful rolling topography. The streams, heavily overloaded, flow in wide braided channels. As they approach the coast, they unite into numerous larger rivers.

The plain, into which the upland gradually merges, is composed of sand, pebbles, and muck, partly covered by muskeg. It is characterized by innumerable steep-sided circular and oblong lakes and meandering rivers (Fig. 7). For some 60 miles the plain has a grade of about 1000 feet and erosion is considerable; but in the belt about 30 miles wide adjoining the sea there is practically no slope, and the area is one of deposition, slightly aggrading. Here connected lakes and forking streams form complex interlacing patterns (Fig. 4). The sea is cutting away the shore line, which is marked by truncated strips and many indented lakes. Steep cliffs all along the shore indicate a mature phase of the encroachment (Fig. 5).

This region, lying between 69° and 71° N., is in the northern part of the belt of permanently frozen ground (the southern limit of the belt here is about 60° N., where the average mean temperature is just below the freezing point). The accompanying table of temperatures at Point Barrow indicates an extremely severe climate, but not one cold enough to account for the present depth of frozen ground. At Cape Simpson, 60 miles east of Point Barrow, a drill hole did not reach the bottom of the frozen ground

[1] See the U. S. Coast and Geodetic Survey's "World Aeronautical Chart," 1 : 1,000,000, Sheet 63, Brooks Range, Alaska.

even at 580 feet. The bodies of mammoth, mastodon, musk ox, and bison,[2] preserved even to hair and skin in this first of all deep-freeze units, are indisputable evidence that we are dealing with the remains of the Pleistocene climate.

Plainly visible in Figures 4, 5, 6, and 9 are the polygenboden, a phenomenon of frozen ground.[3] These were observed by Leffingwell, in an exploration that touched the eastern edge of the region. Cracks in the

TABLE I—TEMPERATURES AT POINT BARROW (28 YEARS OF OBSERVATION)*

°F.	J	F	M	A	M	J	J	A	S	O	N	D
Mean Max.	-9.9	-10.5	-7.6	7.4	25.4	40.0	46.5	44.0	35.6	21.6	5.7	-4.2
Mean Min. . . .	-22.6	-23.6	-22.1	-6.7	13.7	29.4	33.6	33.1	27.6	11.5	-6.3	-17.7
Average	-16.2	-17.0	-14.8	0.4	19.6	34.7	40.0	38.6	31.6	16.6	-0.3	-11.0

* U. S. Weather Bureau data. Maximum temperatures at Point Barrow in 1946 were: June, 53°; July, 73°; August, 66°.

earth's surface, made by wedges of ice, form a sort of irregular checkerboard design of polygons. The average polygon is about 36 feet across, and the cracks may be three yards wide.[4] Leffingwell has minutely described these polygons as seen from the ground, but a feature visible only from the air is that as a rule they are laid out in rough patterns of concentric circles and ovals, a mile to a mile and a half across. From the photographs it is plain that many of the polygon areas are in process of melting out. The interspersed light and dark spots are respectively land and water. It is possible that all polygenboden have such rounded groupings but that this pattern is not discernible from the air if the area has not begun to thaw.

Furthermore, these rounded polygon areas show a gradual updoming toward the center. Sharp[5] and Porsild,[6] in describing such features in areas to the south and east respectively, agree that the freezing of ground water forms buried ice bodies of moderate size. Tyrrell[7] has described large ice bodies similarly formed, called "crystosphenes," that are a slope phenomenon

[2] E. de K. Leffingwell: The Canning River Region, Northern Alaska, *U. S. Geol. Survey Professional Paper 109*, 1919, p. 71.

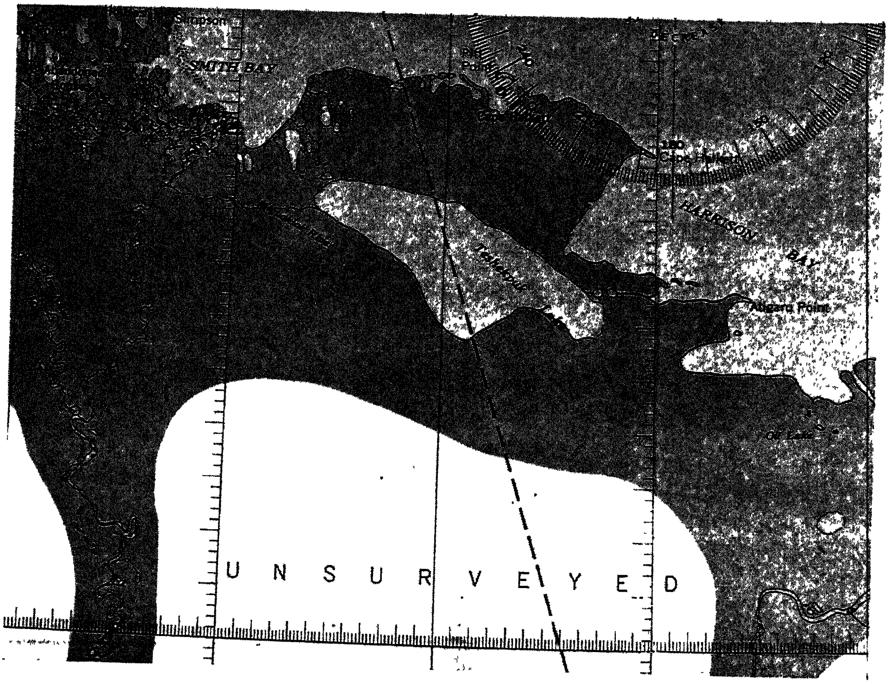
[3] Siemon Mueller: Permanently Frozen Ground and Related Engineering Problems, *U. S. Army, Office of Chief of Engineers, Strategic Engineering Study No. 62*, 1945, p. 220.

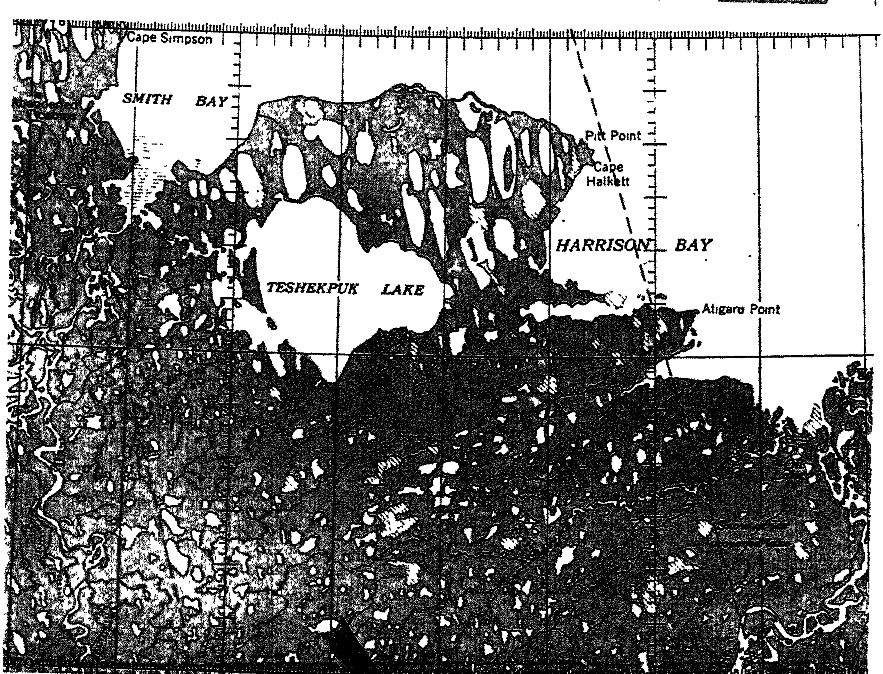
[4] Leffingwell, *op. cit.*, p. 211.

[5] R. P. Sharp: Ground-Ice Mounds in Tundra, *Geogr. Rev.*, Vol. 32, 1942, pp. 417–423.

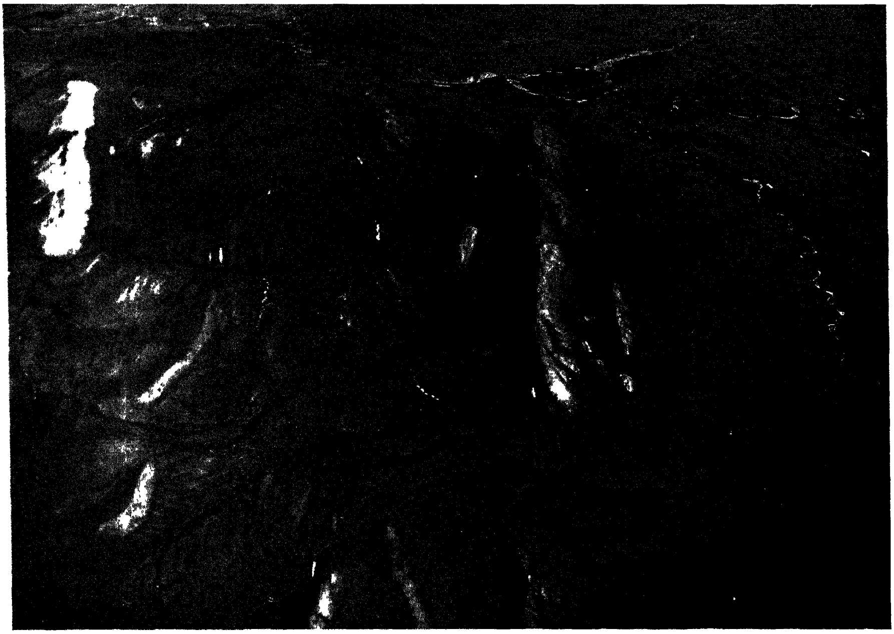
[6] A. E. Porsild: Earth Mounds in Unglaciated Arctic Northwestern America, *Geogr. Rev.*, Vol. 28, 1938, pp. 46–58; reference on p. 55.

[7] J. B. Tyrrell: Crystosphenes or Buried Sheets of Ice in the Tundra of Northern America, *Journ. of Geol.*, Vol. 12, 1904, pp 232–236.





FIGS. 1 AND 2—Above, reproduction in black and white and on a reduced scale of a portion of the AAF Aeronautical Chart, Brooks Range (63), on the scale of 1 : 1,000,000, 1943. Below, the same area from the World Aeronautical Chart, Brooks Range (63), 2nd edit., 1946.



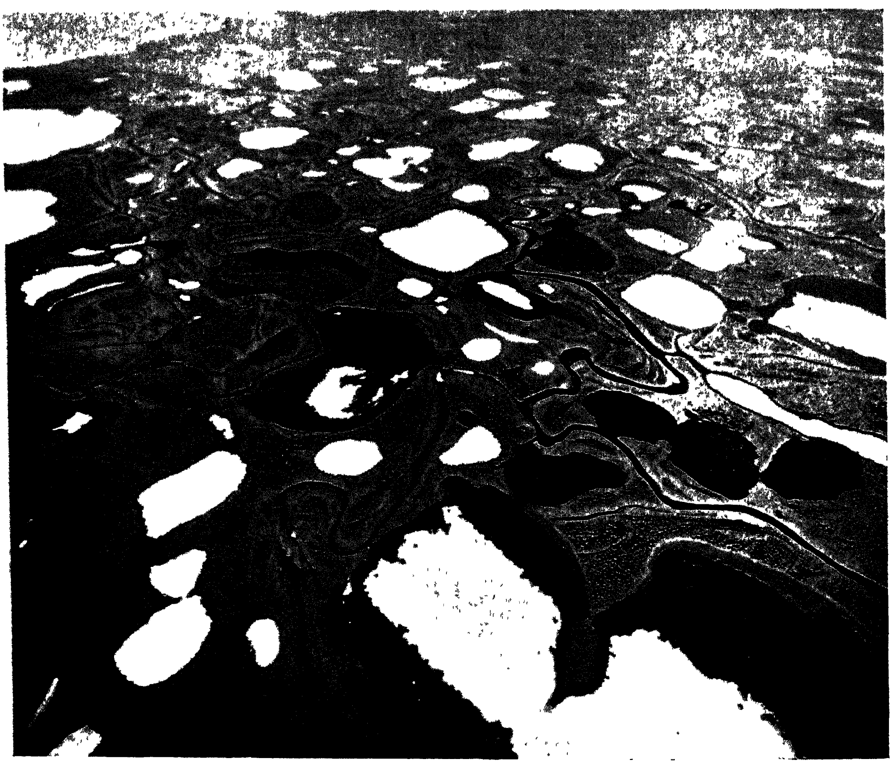


FIG. 3—Upland, a dissected pediment exposing beveled sedimentary strata and trellis drainage. (All photographs reproduced by permission of the Aeronautical Chart Service.)

FIG. 4—Belt adjacent to sea, with compound lake and river patterns; polygon areas in foreground.

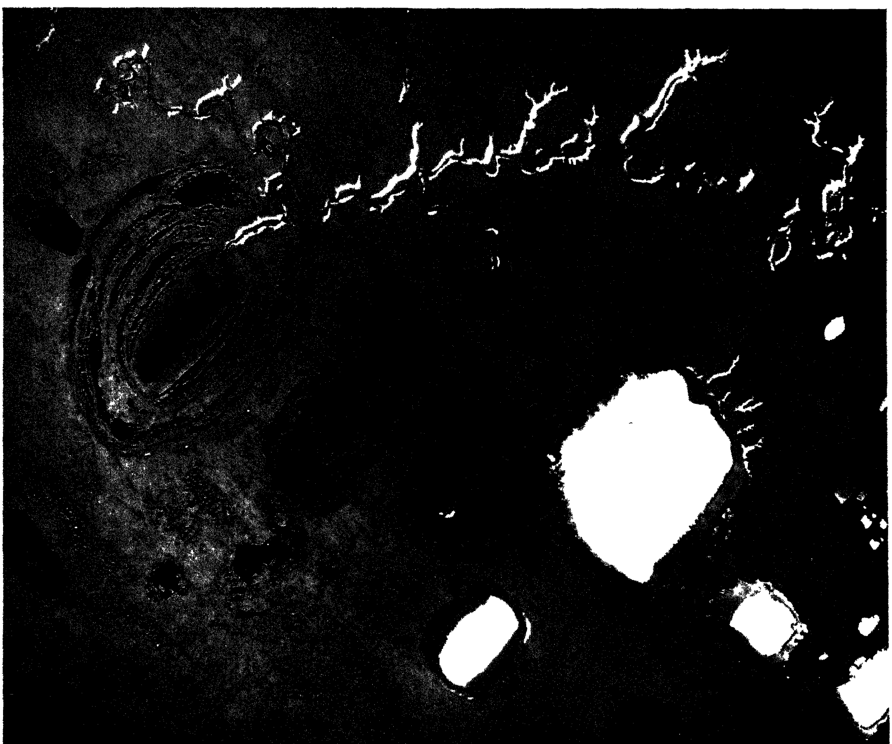


Fig. 5—Arctic shore line with parallel lakes and polygon areas.

Fig. 6—Oval polygon areas in various stages of development. The one at the left has begun to drain itself before being completely thawed.

underlie the polygon areas and cause the updoming and that the freezing of water from underground springs may also be a cause. The plain is the natural area of escape for waters seeping down from the upland sediments.

Formation of Lakes and Pingos

The lakes and the melting polygon areas are commonest in the coastal belt, and from the photographs it seems obvious that one is the result of the other. It is known that the porous soils and gravels of this region carry surface temperatures down several feet; furthermore, many of the polygons are depressed below their neighbors, and some have a small pool in the center. In the summer, when inland temperatures may reach 80°, these factors could easily combine to initiate the thawing of an area. The process would be greatly assisted by updoming in the vicinity, because the elevation would drain to form ponds in a very short time. A large number of the photographs show small shallow lakes grouped around the periphery of a polygon area; one photograph when viewed through the stereoscope even shows a mass of frozen ground remaining in the center after complete melting of the surroundings.

It has been suggested that many lakes are formed by the melting out of "pingos," the largest mounds discovered in these Arctic regions, so named by Porsild. These may reach a height of 230 feet and a diameter of 600 and often have a miniature lake in their craters. They have arrested the attention of all explorers of these parts, but when the plain is viewed from the air, it is evident that they are far less prevalent than the rounded polygon areas. Probably only an occasional lake results from thawing and collapse of a pingo.

The Lake Cycle

Many of the lakes shown in the photographs are narrow oblongs perhaps three to four miles long, apparently elongations of the original polygons (Figs 5 and 10). Out of 30 such lakes in photographs that had been oriented with the line of flight, 20 were found to trend southeast-northwest. This direction is at right angles to that of the prevailing winds of today but is the same as that of the winds from the Cordilleran icecap that prevailed during interglacial periods. In summer these winds would have set up strong wave action in the lakes, which could have undermined the cliff walls of soft sands and gravels and elongated the lakes in the direction noted. This hypothesis for the enlargement of the lakes suggests that some of them have an ancient history.

Other lakes, smaller and more rounded ovals, trend in the direction of the present-day prevailing winds, and it is quite possible that in summer these lakes are being enlarged by wave action.

Indications are fairly conclusive that in the winter the lakes are enlarged by ice shove. Floating ice cakes were seen in many lakes, and also soft mud at the base of the cliffs (Fig. 9). We know how ice overrides the banks of frozen lakes in New England; in this region, too, the ice cakes must advance and grind away at the cliffs, and when they start to melt, the eroded material falls to the lake bottom and becomes mud.

The most rapid development of an oblong lake would take place by the joining of two adjacent lakes. This seems to be common. In Figure 4 the peninsulas jutting from opposite sides of one lake must originally have been joined. In Figure 9 the three ice cakes in the three sections of the lake indicate a former trio of separate lakes. The dark patches suggest the deep central waters of the original lakes, the gray indented border the shallow waters at the margins.

Certain drainage situations also enlarge lakes. A stream cascading from a wall drains the waters of a polygon area into a small lake; farther on, the waters drain into a larger lake at a still lower level. Such steppingstone drainage has enough erosional force to wear down the barrier between the lakes and eventually will join the small to the large in the form of an embayment.

As the lakes enlarge, they also deepen; the dark coloring of the photographs reveals the depth of the water in the central parts. Leffingwell states that in this area a lake half a mile wide may reach a depth of 1000 feet. Since the lake waters are warmer than the frozen earth, it is plausible that they are able to thaw the lake bottoms. Frozen ground never reaches very low temperatures and becomes progressively warmer at deeper levels.[8] In a shallow lake, thawing would take place only during the mild season, while the lake remained unfrozen; but a deep lake is active all winter, and under the insulation of a massive ice cover its waters could continue to thaw the frozen bottom. In addition, convection currents in the lower half of the lake would further the thawing. The water immediately in contact with the lake floor would be nearer the freezing point than the middle layers, which would be at 4° C.; and the lighter bottom water would be replaced by warmer water from above. Underground springs may drain into deep lakes and also aid the thawing.

As capillary action and solifluction work down only a few feet and in

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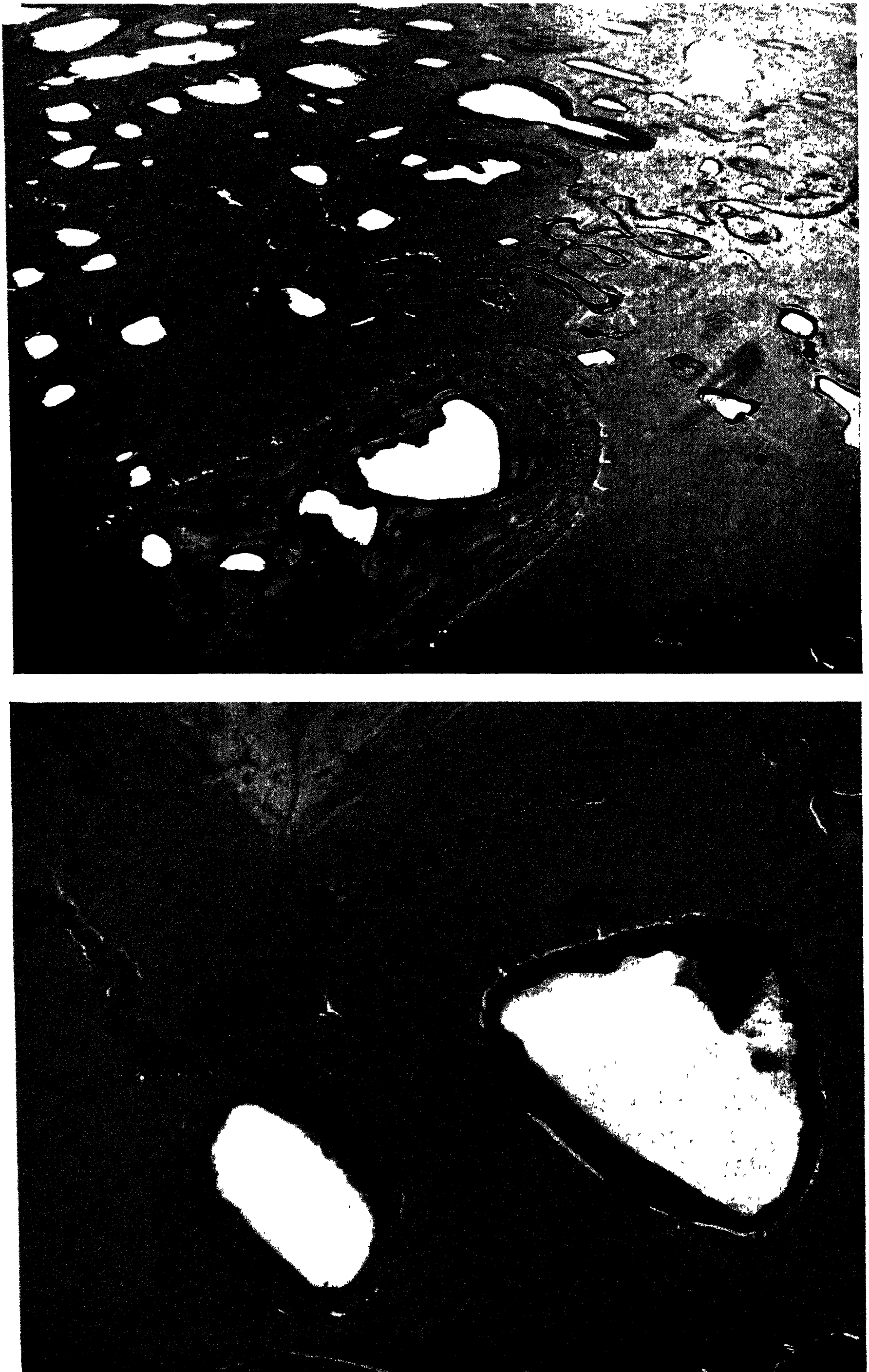
[8] Leffingwell, *op. cit.*, p. 185.



FIGS. 7 AND 8—Oblique and vertical photographs of adjacent areas (note overlap). Figure 7 shows coastal plain with lakes and meandering river; Figure 8 shows divergence of stream (top center) and abandoned channel to right. Lake above has been destroyed by stream; note cliff border of original lake. The lake at the lower right is draining by a self-induced stream.

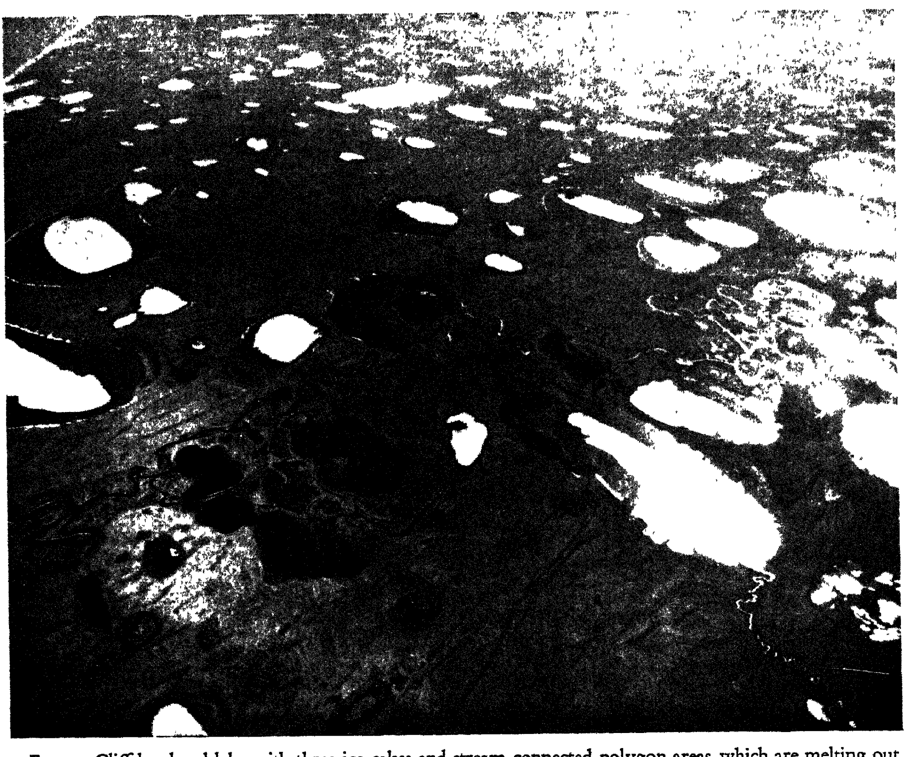


Fig. 9—Cliff-bordered lake with three ice cakes and stream-connected polygon areas, which are melting out.
Fig. 10—Lake in center destroyed by meandering river.

some places have no effect because of the blanketing action of the muskeg, it follows that lake action would be the chief factor to cause thawing to any depth. When first formed out of the polygon area, a lake may be about 10 feet below the original surface, probably because frozen ground, which contains a large percentage of ice, melts out into a smaller volume of water. As is evident in the photographs, in old age the lakes develop cliffs 100 feet high or more. The photographs were taken in summer; hence the cliffs must be permanently frozen, or their sands and gravels could not stand at such an angle of repose.

A lake may be destroyed at any stage. In Figure 6 a polygon area has begun to drain itself even before it has been completely thawed. In Figure 8 a fully formed but youthful lake has started to drain, also by means of a self-induced stream. When the seasonal snow cover melted, the waters of the lake spilled over, cutting into the soft alluvium; they now pass into a shallow adjacent lake and from this seek the local base level of a deeper lake in the neighborhood; eventually the waters will cut down their channel to the bottom of the original lake and empty it.

Mature lakes, even the deepest, may be destroyed by the coastal rivers, which, as they meander over the plain, are cutting down to base level. In Figures 7 and 8, which form a pair, a stream has cut so near a large lake at a lower elevation that part of the stream has become diverted. The lake has filled up, broken out at the far end, and spilled its contents, including fine sand, into another stream. This leaves only a series of ponds in what was once a deep body of water. The first stream will soon flow into this basin, taking a new channel at right angles to the old and leaving the scar of the abandoned channel.

In another development, a meandering stream has cut the land to the same level as the bottom of a deep lake (Fig. 10). It has now undermined the lake wall and meanders over the lake floor, which has thus become incorporated into the broad flood plain of the river system.

Such destruction is the natural fate of the lakes. At the same time it lowers the plain and shaves off the frozen ground. Eventually all the present lakes will be destroyed by river meander and a new plain formed. The cycle will continue until all 500 feet, or thereabouts, of frozen ground has been melted out and the last vestiges of the Pleistocene have vanished.

MANITOULIN ISLAND

D. F. PUTNAM

MANITOULIN ISLAND, or the Grand Manitoulin, in the northern part of Lake Huron, has a unique geographical personality. Its flat rock plains, its long perpendicular cliffs, its great inland lakes, contrast strongly with the quartzite ridges of the Canadian Shield. Cultural aspects, too, are unique. Indian and white settlements stand side by side. For the most part the Indian has adopted the white man's economic system, but he still seems to be living a pioneer life in his whitewashed log house. The summer visitor finds Manitoulin an attractive place; to the geographer it is both interesting and stimulating.

According to the survey reports, the land area of Manitoulin is 1073 square miles—it is said to be the largest "fresh-water" island in the world—and it contains more than 100 inland lakes, the three largest of which, Kagawong, Mindemoya, and Manitou, together cover a water surface of more than 65 square miles. The judicial district of Manitoulin includes a small portion of the mainland as well, but most of the settlement is on the island.

The Terrain

The island is part of the Niagara cuesta, the rim of the great dolomite saucer that underlies the Michigan basin. If it were not for a few low spots, this rim would divide Lake Huron into two and Manitoulin would be part of a long land arc extending from the Bruce (Saugeen) Peninsula to northern Michigan.

In structure the island may be compared to a giant stairway with three broad, in-sloping treads and two risers, escarpment cliffs, though the arrangement is apparent only in the broad, eastern part (Fig. 2). The topmost member is the Lockport dolomite (Middle Silurian), which covers about two-thirds of the island. The perpendicular cliffs that mark the edge of this formation are outstanding: a striking headland projects into Bayfield Sound; and High Hill, between Manitou Lake and West Bay, is more than 500 feet above the level of Lake Huron and more than 1100 feet above sea level. In both places the southward dip of the cap rock can be clearly seen. Below the Lockport dolomite lies the Manitoulin dolomite (Lower Silurian), on which the widespread rock plains are developed. In places it too is bordered by steep cliffs, though they are not so high as those of the Lockport. Between the two dolomites lie the reddish shales of the Cabot Head member. The northernmost part of the island consists of rock plains under-

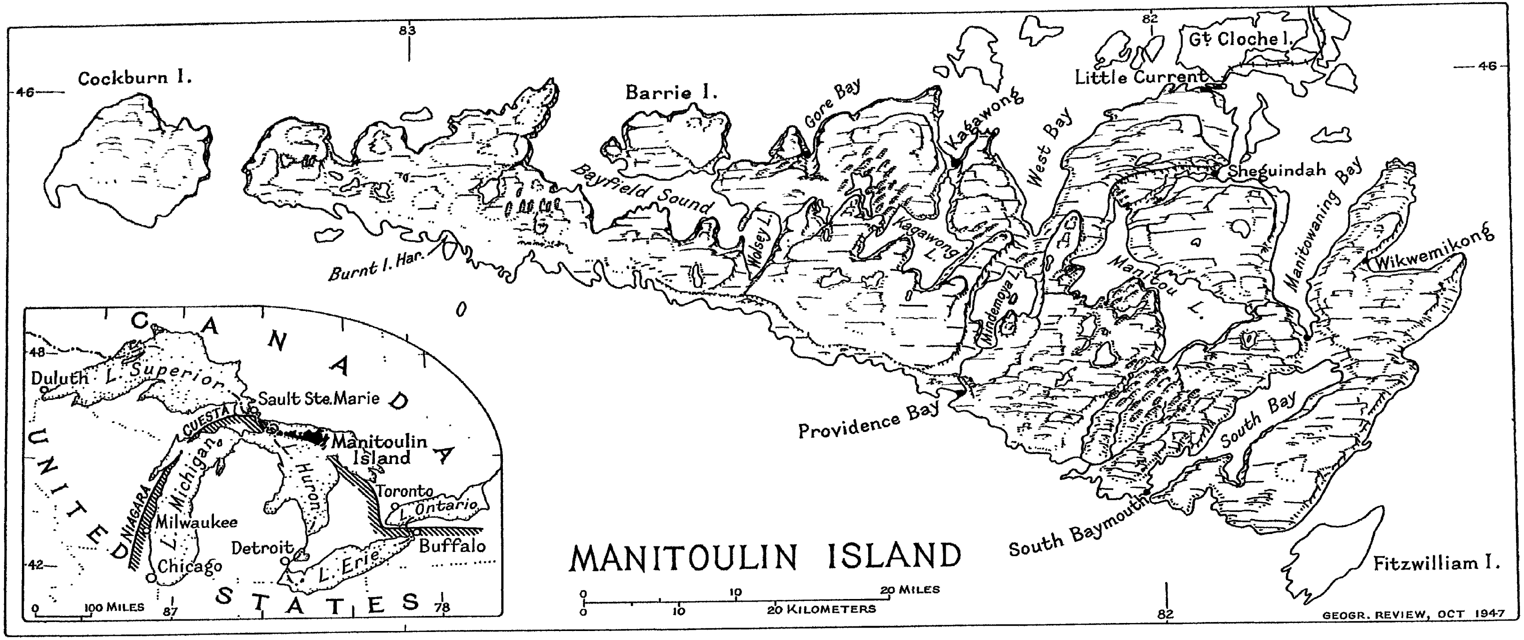


Fig. 1—Physiographic diagram of Manitoulin Island. (Drawn by L. J. Chapman.) The inset shows general location and relation to the Niagara cuesta.

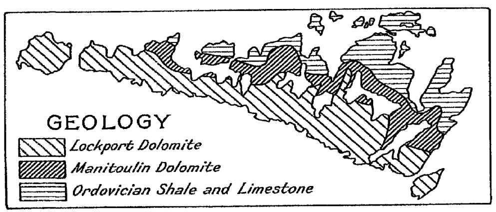


Fig. 2—The chief geological formations of Manitoulin Island. (After Canadian Geol. Survey.)

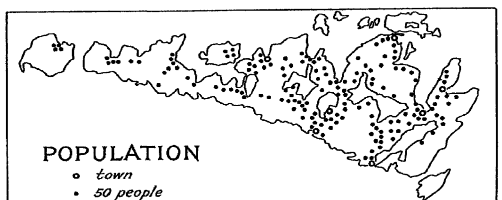


Fig. 3—Rural population is chiefly on the deeper soils of the glacial till and lacustrine sediments.

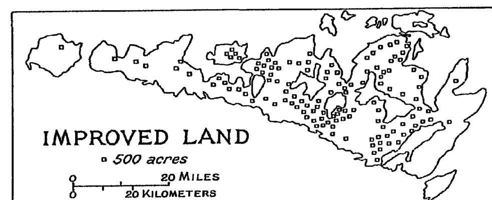


Fig. 4—The distribution of improved land is strongly correlated with the deeper drift.

lain by Ordovician shales and limestones, probably to be correlated with the Utica and Trenton series in Southern Ontario.

The island bears strong evidence of Pleistocene glaciation. Only a small part of the surface is covered with deep drift, but in many places striae are well preserved under a few inches of soil. Where the dense strata of the Manitoulin dolomite outcrop in the area south of Gore Bay, the rock is smooth and polished. Where it is protected by a few inches of drift, its surface is so well preserved that blocks are cut for use as hearths and mantles. The surface of the Lockport dolomite is rougher, but striae are sometimes found on it. In places there are curious elongated parallel ridges, apparently sculptured by the ice.

For the most part the striae point about 40° W. of S., agreeing well with those seen on the Bruce Peninsula. Toward the west end of the island, however, the direction is 15°–20° W. of S. Traces of another and earlier set of striae, trending about 60° E. of S., were seen on Barrie Island.

The direction of ice movement is also shown by the axes of the drumlins. Manitoulin has nothing comparable with the large drumlin fields of Southern Ontario, but there are a number of groups of drumlinoid till ridges and a few well-formed drumlins, the most important of them the one at Tehkummah, in the southeastern part of the island; others are found north of Kagawong Lake and around Silver Lake.

High Hill seems to have been the only part of Manitoulin Island that was not submerged by Lake Algonquin. Some of the old lake levels are marked by strong gravel beaches, but in other places there are boulder pavements or expanses of bare rock from which the waves have washed all the finer materials. There are also some finer lacustrine deposits: the best are in the valleys of Black Creek and the Manitou River, the lowlands both north and south of Mindemoya Lake, the Spring Bay area south of Kagawong Lake, and the Burpee and Evansville flats near Wolsey Lake.

The effects of the Nipissing Great Lakes are also evident, not so much along the precipitous north shore, though here and there are good gravel beaches from 30 to 50 feet above the present water level, but along the south shore, where a belt one to two miles in width was covered by Nipissing waters and where cliffs, sand beaches, and dunes are numerous. For the most part it is a rather desolate waste of rock plain from which the forest has been cut and burned. The waves of Lake Huron have made only a shallow nip in the face of the gentle dip slope. Along this shore, Michael Bay, Providence Bay, and other inlets provide sufficient depth for barges and other shallow-draft boats.

FIG. 5—High Hill, 1120 feet above sea level, seen across Manitou Lake from the southeast. Stony till on the slope in the foreground.

FIG. 6—A promontory of the Niagara cuesta as seen from the east across Campbell Bay.

FIG. 7—View from the brow of the Niagara escarpment between West Bay and Kagawong Lake overlooking the flat rock plain developed on the Manitoulin dolomite.

FIG. 8—View from the brow of the Manitoulin escarpment overlooking the lowland on the Ordovician rocks near Little Current. The sky line is marked by the white quartzite ridge, the Cloche Mountains, on the mainland.

FIG. 9—The steep-sloped north shore of Manitoulin Island. Pulpwood piled for export.

FIG. 10—The gently sloping south shore of the island; note the low "nip" cut by the waves of Lake Huron.

CLIMATE, VEGETATION, AND SOILS

The climate of Manitoulin is somewhat less severe than that of the near-by mainland of Northern Ontario.[1] It may be characterized as one of cold, snowy winters, late springs, cool, dry, and sunny summers, and open falls.

Two meteorological stations have rather extended records of observations, Gore Bay on the north shore and Providence Bay on the south shore.

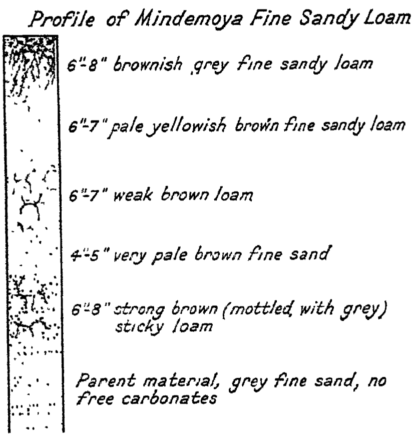


FIG. 11—Soil profile in an area of the best soils on Manitoulin Island.

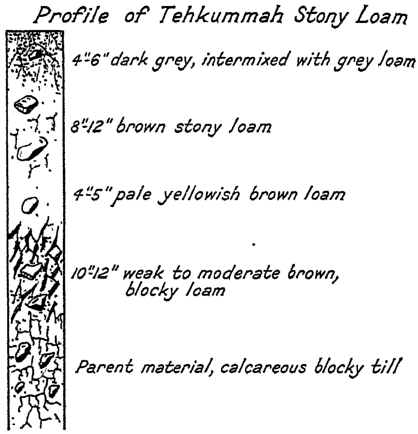


FIG. 12—Shallow soil profile on calcareous drumlin till.

The mean annual temperature at both stations is 40° F. Winter temperatures are a little lower on the north shore; summer is slightly cooler on the south shore. The highest temperature ever recorded was 100° F., the lowest −41° F. The extreme range, 141° F., is rather great for a region completely surrounded by water. The North Channel freezes in winter, however, and thus does nothing to modify the low temperatures. The frost-free period averages about 125 days, extending from the last week in May to the last week in September.

Manitoulin has a comparatively moderate rainfall, 28 to 30 inches a year, but snowfall ranges from 83 to 118 inches. The rainfall for the three summer months, June, July, and August, is only 6 to 6.5 inches; moreover, it is rather unreliable. Droughts (months with less than one inch of rainfall during the growing season) occur in three out of five years.

The island was originally covered with a mixed forest of conifers and hardwoods. Sugar maple, beech, and yellow birch with pine, hemlock, and

[1] It is therefore included with Southern Ontario in the discussion "The Climate of Southern Ontario" by D. F. Putnam and L. J. Chapman, *Scientific Agriculture*, Vol. 18, 1938, pp. 401–446.

white spruce occupied the uplands; excessively dry places had jack pine; the swamp forest consisted of white cedar, elm, white and black ash, and red maple. The present "second growth" includes a very large proportion of poplar and white birch. Because of the shallowness of so much of the soil, there is a great deal of rather open, scrubby, and almost worthless woodland.

Pedologically, Manitoulin Island may be considered an area of transition. Typical podzols are to be found, especially on sandy-textured materials, but brown podzolic and gray-brown podzolic soils dominate where drainage is normal. Fairly often a brown podzolic soil (or sometimes a true podzol) is superimposed upon a gray-brown earth. In many places the material is so high in lime that normal profiles have not yet been developed.

The best soil seems to be the silty or fine sandy loams of the lowlands around Mindemoya (Fig. 11). Soils on the calcareous tills of the drumlins are very shallow (Fig. 12). Unfortunately for Manitoulin, the best soils occupy only a small part of the island.

Settlement and Population

When Champlain arrived on the shore of Georgian Bay in 1615, he encountered a tribe of Indians who called themselves "Odahwahs," or, as it is generally written, Ottawas. These people belonged to the great Algonquian family that inhabited the northern forest.

Manitoulin Island was at that time occupied by three subtribes of the Ottawas. In the summer of 1652 they were dispersed by the Iroquois, who had already annihilated the Huron settlements of the Penetang peninsula. Only a small remnant of one of the tribes, the Pikes, later came back to the island. They were visited by missionaries occasionally until about 1700; then for nearly 125 years there is a blank in the history of Manitoulin. Tradition has it that in a certain dry season fire spread over the island, destroying the forest and the game on which the Indians depended for a living. Not until the early nineteenth century did the Indians return.

In 1836 Sir John Colborne, lieutenant governor of Upper Canada, conceived the idea of moving all the Indians in that region to Manitoulin Island. The scheme was a failure. The only Indians who actually settled there were a few from the north shore of Lake Huron, from the north shore of Lake Superior, and from Michigan.

In 1862 a treaty with the Indians provided for white settlement of the island. The Indians of the east end refused to sign, however, and a block of 105,000 acres there still remains as "Manitoulin unceded." By 1880 the ceded part had been divided by surveyors into townships and lots, but not until

1946 did government surveyors set foot in the unceded territory, and then only to provide legal titles for returning Indian veterans of World War II who wished to take up land under the auspices of the Department of Veterans Affairs.

The island was settled rapidly. By 1891 it had a population of 10,000, but since that time little change has been recorded. In 1941, of the 10,000 inhabitants, about 8000 were white and 2000 Indian.

The population is almost completely rural, the two towns, Gore Bay and Little Current, having a combined population of less than 1800.[2] There are several small nucleated settlements, including Manitowaning, the first white settlement on the island, established in 1838, Mindemoya, Sheguindah, Providence Bay, Kagawong, and the Indian village of Wikwemikong. The most thriving of the small white settlements is Mindemoya, a farmer's supply point in the central part of the island.

Forestry and Fishing

Originally the whole of Manitoulin Island, 687,000 acres, was forested, and forest, unfortunately much despoiled, still occupies a large part. Today most of the wood is cut for pulp; both spruce and poplar are used. It is hauled to the shore, pushed into the water, and towed out to deep water, where it is picked up by a steamer, using an ingenious adaptation of the clamshell bucket, and cheaply transported to any milling point. There are no large mills on the island, but a few small ones cut for local use.

The Indians of Manitoulin are active woodsmen. In 1945–1946 they cut more than 8000 cords of pulpwood from their reserves. They are also in demand as pulpwood cutters for the timber companies operating in the forests of the mainland.

Commercial fishing has been carried on in the waters surrounding the island since about 1880. For years it was an industry of some importance, employing about 100 boats and 250 men. In 1931 the total catch was more than 3,000,000 pounds, two-fifths of it lake trout, but since that time it has greatly decreased. In the summer of 1946 the fishing was so poor that tugs were laid up and operations suspended in midseason.

The condition of the Great Lakes fisheries today is a matter for international concern. Various government-sponsored scientific investigations are endeavoring to explain the disappearance of commercially valuable species.

[2] For a convenient reference based largely on the 1941 census see "Ontario Population Maps," Sanford Evans Statistical Service, Winnipeg, 1945.

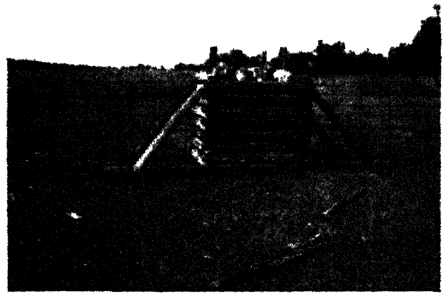


FIG. 13 FIG. 14

FIG. 13—Treasure Island in shallow Mindemoya Lake is a striking outlier of the Niagara cuesta.

FIG. 14—A fence "anchor" on the shallow range land. On much of the island the soil is too shallow for sunken posts, and fences must be secured by rock-filled cribs.

FIG. 15 FIG. 16

FIG. 15—A part of the Indian village of Wikwemikong. The houses are located on old beach terraces of glacial Lake Algonquin

FIG. 16—An Indian homestead in the Rabbit Island district a few miles north of Wikwemikong.

FIG. 17 FIG. 18

FIG. 17—Stone church in the village of Wikwemikong.

FIG. 18—An Indian residence in the village at West Bay. Note the neat, whitewashed log construction and the picket fence.

FIG. 19—A view in the Lake Nipissing plain along the south shore of the island. Note the large exposure of bare rock and the poor regeneration of forest.

FIG. 20—Old sand dunes along the Nipissing shore line now being regenerated.

FIG. 21—Typical general farm in Gordon Township, just west of Gore Bay, situated on deeper drift.

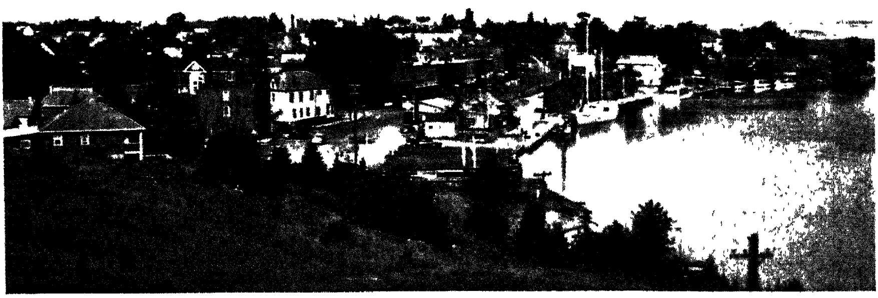


FIG. 22—Typical beef herd on "range" land in the interior of the island.

FIG. 23—The town of Little Current is a favorite yachting rendezvous. Along the water front may be found pleasure craft from all parts of the Great Lakes.

FIG. 24—Little Current is also an important lake port. Here coal is unloaded for use in the Sudbury mining area.

Agriculture

Only some 278,000 acres, about 40 per cent of the land area of Manitoulin, is occupied as farmland. According to the census of 1941, there were 1151 farms in the district; the average farm was thus some 250 acres, about double the average size for the province. On the other hand, the crop area was 55,000 acres, or about 50 acres to a farm, which is not quite as large as the provincial average. About 110,000 acres, almost 100 acres to a farm, is devoted to pasture, whereas the average for the province is about 40 acres. The emphasis on grazing is confirmed by figures for livestock—21,000 cattle and 19,000 sheep.

On the whole, there are two main land-use patterns. Where there is some depth of lacustrine materials or of the less stony till deposits, a mixed crop and livestock agriculture is carried on. The stonier and the shallower soils are given over to grazing.

Many of the farmers have achieved a fairly practical organization of activities. They own small farms of 100 acres in the areas of better soil, on which they grow their crops and keep their small herds of breeding stock. In addition, they have from a hundred to several hundred acres of "range," on which they pasture their growing animals during the summer. Some farms are large; more than a hundred in the district are 500 acres or more.

Most of the cattle are of the beef breeds. Herefords dominate because of their adaptability to range conditions. They are well-bred and of good quality. The island has for years been a tuberculosis-free area; consequently, the range animals are in good demand among the farmers of Southern Ontario, who finish them for market.

The cattle industry is self-contained. No stockers are imported; the 4000 or 5000 head exported each year represents the normal surplus after the local demand for beef has been satisfied. About half of the trade is transacted privately through drovers, and half at an annual auction held at Little Current. The annual lamb crop is disposed of in the same way.

Dairying is of minor importance, but there are a few good herds of dairy cattle near the towns. There are two creameries, at Mindemoya and Manitowaning. There are no cheese factories, and this is rather odd, because summer dairying and cheese manufacture have long been established on similar shallow soils in eastern Ontario.

A noteworthy development in recent years is the raising of turkeys. In 1930 about 10,000 birds were marketed; in 1945 the number had increased to about 50,000.

Another specialty is fur farming. There are several establishments, one of which, housing several thousand minks and foxes, is the largest in Ontario.

On the whole, agriculture would seem to be the most important economic activity on the island: more than 45 per cent of the population reside on farms. It is, however, a marginal and extensive agriculture, conditioned by isolation and lack of good arable land. Farm population and number of farms continue to decrease, but the area of occupied land remains about the same. The increase in the size of farm unit is, of course, consonant with a grazing economy.

Recreation

In recent years Manitoulin has become increasingly popular as a summer resort; fishing and boating are the chief attractions. Little Current is the yachting center of the north. During the summer its water front is lined with luxurious cruisers from all parts of the Great Lakes. Lodges and cottage camps are found nearly everywhere, but they are especially attracted to the shores of the large inland lakes. About 70 of these establishments were in operation in the summer of 1946, and nearly all of them were booked to capacity. Although considerable numbers come from Southern Ontario, the summer guests of Manitoulin are preponderantly American, with a noticeably large representation from the cities of Ohio. Privately owned summer homes are also numerous, and on the increase.

It is rather curious that the south coast of the island remains almost unoccupied. The small villages of Providence Bay and South Baymouth attract some visitors, and Burnt Island, toward the west end, is a fishing station, but otherwise the 80-mile coast line is uninhabited, even in the summer.

Transportation

Railroad facilities exist only at Little Current, where the Cloche Islands and the adjacent peninsula permit an approach from the mainland. Connection is made with the Soo line of the Canadian Pacific Railway.

The highway from the mainland follows the same route and makes use of the same bridge to reach the island. Manitoulin roads are gravel-surfaced and rather dusty except for certain oil-treated stretches. A program of bituminous paving has begun and will eventually take in the main highways.

The early settlers of Manitoulin depended entirely on water transportation, and it remains important today. A ferry service is maintained between South Baymouth and Tobermory, at the tip of the Bruce Peninsula, a

distance of about 28 miles. Although two boats were in service in 1946, each with a capacity of 12 to 14 vehicles, making 4 to 6 trips a day, a delay of more than 24 hours was sometimes necessary. This bottleneck will be taken care of in the future by a new and much larger ship, the *Norisle*, which has been placed on the route. Regular steamship service is also maintained from Owen Sound to Little Current and Manitowaning.

Little Current is of considerable importance as a Great Lakes port. Besides its facilities for passenger traffic, it has extensive coal docks, through which pass cargoes destined for the mining districts of Northern Ontario. Sudbury, the most important nickel-producing center in the world, is only 80 miles distant. The capacity of the port is about 450,000 tons a season.

Air transport is not being neglected. Little Current is building a small airport on the flat rock floor of Great Cloche Island just north of the town. Near Gore Bay a huge new government airport is under construction, which will be used by the ships of Trans-Canada Air Lines. The lakes and bays offer facilities for seaplanes. Summer visitors are already bringing their own planes, and more will probably do so in the future.

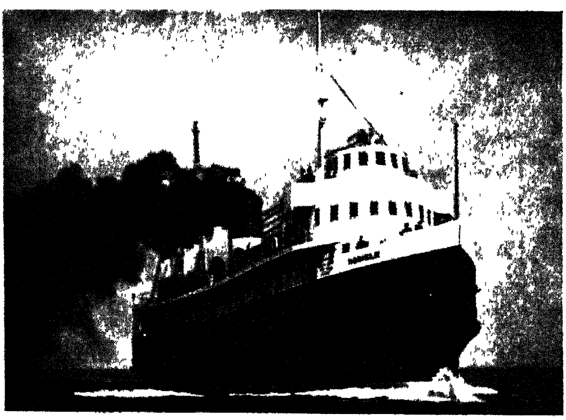


FIG. 25—The S. S. *Norisle*. (Photograph by courtesy of the Owen Sound Transportation Co. Ltd.)

AMERICAN GEOGRAPHICAL SOCIETY

Address by Professor Ahlmann

Professor Hans W:son Ahlmann, Director of the Geographical Institute of Stockholm University, spoke at the house of the Society on June 19, 1947, on "The Present Climatic Fluctuation and Its Investigation." He discussed the recent amelioration of climate observed in various parts of the world, especially in the Arctic and sub-Arctic, as recorded by meteorological observations and shrinking glaciers and other changes indicative of a gradual increase in the mean temperature. He also reviewed the principal results of his own investigations of the regimen and variations of glaciers in Scandinavia, Iceland, Spitsbergen, and Greenland. In closing, he expressed the hope that a systematic and comprehensive program of glaciological research would be established in North America, which could be coordinated with similar studies being undertaken in other continents. He emphasized that observations of the variations of the termini and lower parts of glaciers, although they provide useful data, are inadequate for determining the causes of glacier variations and the general factors involved. Of greater importance are detailed studies of the hydrological balance of the glacier as expressed in the annual rate of accumulation and the rate of melting and variations in these factors. Only from such studies, in the area of accumulation as well as in the area of ablation, can a more precise determination be made of the causal connection between glacier variations and climatic change.

Professor Ahlmann is organizing a Norwegian-Swedish-British expedition to be based in Queen Maud Land, in the Atlantic sector of the Antarctic Continent, from the autumn of 1948 to the spring of 1950. The expedition will carry on meteorological and glaciological observations, which will be correlated with simultaneous observations made at stations on other continents and in the Arctic. Professor Ahlmann urged that a similar program of observations be undertaken in North and South America in an effort to obtain additional precise evidence that may lead to an explanation of the pronounced climatic change now taking place. As he pointed out, this is the first one of the many climatic variations in the earth's history that we can observe, measure, and possibly explain. It is therefore of importance that its study be undertaken on a closely coordinated, world-wide basis.

New Edition of "Aids to Geographical Research"

In August of this year the Columbia University Press published for the Society a new and completely revised edition of "Aids to Geographical Research," by John Kirtland Wright and the late Elizabeth T. Platt. The first edition, by the senior author, appeared in 1923 and has long been out of print. It dealt almost exclusively with geographical bibliographies and periodicals. The new edition is a considerably more comprehensive work, dealing, in addition, with a selection of atlases, gazetteers, and other geographical reference works. It is designed to serve the needs of students, librarians, teachers, and research workers in geography and related fields. Dr. Wright is now Director of the Society; Miss Platt, who for many years was Assistant Librarian and served as Librarian from 1937 until her death in May, 1943, gathered most of the references to bibliographies and periodicals that appeared in the two decades from 1923 to 1943. The volume constitutes *American Geographical Society Research Series Number 22.*

Our October Contributors

The expedition to the Río Ventuari region was the latest of a number of expeditions into the sandstone mountains of southern Venezuela organized and led by MR. PHELPS. Its prime purpose was ornithological—the collection of subtropical birds to be used in the preparation of a monograph on the birds of Venezuela in which Mr. Phelps is collaborating with his father. At the same time the expedition afforded MR. HITCHCOCK, Assistant Director of the American Geographical Society and head of its Department of Hispanic American Research, the opportunity of closing some gaps in our knowledge of the geography of the region. SR. GALAVIS is petrographer of the Creole Petroleum Corporation.

MR. ALLEN is the Missouri Botanical Garden's representative in the Canal Zone, where he is continuing field studies and collections toward the "Flora of Panama," begun many years ago and now being published. For three years, 1943–1946, he served as field technician, Rubber Development Corporation, in charge of rubber production in the Meta, Vaupés, and Leticia areas.

MR. UNGER is Economic Officer for the Division of Southern European Affairs, United States Department of State. In 1946 he served as economist on the American Delegation of the Commission to Investigate the Italo-Yugoslav Boundary and traveled extensively through Venezia Giulia; later he was attached to the United States staff of the Council of Foreign Ministers and the Paris Conference as economic adviser. He returned to Trieste for the first two months of 1947 as international secretary of the Trieste Commission of Inquiry, sent to Trieste by the Council of Foreign Ministers. To the *Geographical Review* he has contributed the article "The Chinese in Southeast Asia" (April, 1944).

PROFESSOR HU is director of the Institute of Geography of the National Central University, Nanking, China. For some months last year he worked at the Department of Geography, University of Maryland, on a climatic atlas of China to be published jointly by the University of Maryland and the National Central University at Nanking.

MR. IVES is especially interested in the physical geography of the western United States and has written on mountain glaciation, mountain weather, desert floods, and field methods therein, and also on certain human relations; for instance, "Early Human Occupation of the Colorado Headwaters Region: An Archeological Reconnaissance" (*Geogr. Rev.*, July, 1942). On the completion of his wartime service with the Army he became Teaching Fellow in the Department of Geography, Indiana University.

MR. CABOT, formerly curator of the Geological Museum at Harvard University, has since been attached to the United States Geological Survey, working on map compilation for the AAF. His special field is the geology of New Mexico. To the July, 1946, number of the *Geographical Review* he contributed the article "Dual-Drainage Anomalies in the Far North."

PROFESSOR PUTNAM is assistant professor of geography at the University of Toronto. He is especially interested in Canadian geography, with emphasis on soils, landforms, climate, and agriculture. With L. J. Chapman of the Ontario Research Foundation he has published a number of articles on Southern Ontario.

NORTH AMERICA

NEWFOUNDLAND: SETTLEMENT AND ECONOMY. It is an unfortunate fact that Newfoundland, the oldest of the British colonies, "has been almost completely neglected by modern geographers." Professor Griffith Taylor has made a start at filling this lacuna in regional geographical literature with a pamphlet entitled "Newfoundland: A Study of Settlement with Maps and Illustrations," published in 1946 as one of the *Special Series* of the Canadian Institute of International Affairs. Settlement is mainly peripheral, with numerous small fishing villages fringing the coast. St. John's, the capital and the only fair-sized town, contains about 55,000 of the island's 310,000 inhabitants. Corner Brook and Grand Falls, both paper-mill towns, come next with about 12,000 and 6000 respectively. (The patterns of the principal towns are delineated by sketch maps of the block-diagram type showing the main streets with relation to the topography of the site, and the locations of mills, houses, shops, and public buildings.) There are only two inland penetrations of settlement, one along the railroad between Corner Brook and Deer Lake, the other extending from Botwood to Grand Falls to Buchans, also along the railroad.

Agriculture is governed by topography, soils, and climate. Only 0.4 per cent of the total land area is devoted to crops (largely potatoes, vegetables, and hay); the most promising areas are the Humber and Codroy Valleys. A fair idea of the principal commodities in the island economy and their relative importance may be gained from a list of export values in 1943–1944: paper, pulp, and lumber, 44 million dollars; fish, 18 million; minerals, 8 million; and agricultural products, 34 thousand. According to an expert analysis of Newfoundland economics published recently (R. A. MacKay, edit.: Newfoundland: Economic, Diplomatic, and Strategic Studies, Oxford University Press, Toronto, 1946; reviewed at length in the *Canadian Journ. of Econ. and Polit. Sci.*, May, 1947), there is little chance that these figures can be substantially raised in the near future. There is some doubt as to whether the island could support another paper mill; and the fisheries and mines, although exploitation could be considerably increased, are faced with competition and limited markets. In short, "the main hope for Newfoundland to attain a substantially higher level of national income . . . lies in improved conditions of international trade in the whole Atlantic region."

SHADED-RELIEF EDITIONS OF UNITED STATES TOPOGRAPHIC MAPS. During the war the United States Geological Survey experimented with many different methods of representing topography accurately and yet in a way that would have meaning for the nonspecialized user. One of these methods, shaded relief, has been described by J. E. Mundine and Hal Shelton (Visual Topography, *Photogrammetric Engineering*, Vol. 11, 1945, pp. 272–278). By a "gradual transition of color from a cool receding color (green) in the low areas to a warm color (red brown) on the higher slopes" the relative elevation is indicated. "No attempt is being made to indicate exact ranges of elevation in the manner of a gradient tint." "A map of this new kind has a greater descriptive vocabulary by the use of tone and color in addition to line as fundamental elements in its symbolism. And by making the relative tone and color correspond to the appearance of physical form in nature, these symbols at once become easily recognizable and almost universally understood. This combination gives a complete and continuous description of relief, able to supplement . . ., or

replace for most uses, the contour line which is only capable of describing the land form at spaced intervals. Such symbolism, properly applied, almost achieves the equivalent of an infinitely small contour interval." Construction of such maps "demands a synthesis of the impersonal scrutiny of a scientific interpreter of geometric measurements, with the sensitive evaluation, organization and representation of a trained artist." Aerial photographs, especially trimetrogon pictures, are valuable guides in the preparation of a shaded-relief map.

Making use of the new techniques developed during the war, the Geological Survey has recently (1946) issued a special shaded-relief edition of the "Map of Yosemite Valley, Yosemite National Park, California," on the scale of 1 : 24,000. The shaded relief, overprinted on the 1938 edition of the contour map, produces a striking three-dimensional effect. The same method has also been used for the Orbisonia, Pennsylvania, quadrangle (shaded-relief edition, 1944), in the folded Appalachian region. Here the results are not quite so impressive, perhaps because the major ridges have relatively smooth, unbroken slopes for many miles a condition that offers little opportunity for tonal variation.

THE GREAT KANAWHA VALLEY. Utilization of brine, coal, oil, and natural-gas resources in the Great Kanawha Valley of West Virginia dates from the latter part of the eighteenth century and the first half of the nineteenth. During the past 30 years it has formed the basis for the rapid growth of a chemical industry (Leslie Martz Davis: Economic Development of the Great Kanawha Valley, *Econ. Geogr.*, Vol. 22, 1946, pp. 255–267). Large chemical plants are rather closely spaced along the upper and middle valley and account for the greater part both of industrial production and of labor employment. Subsidiary activities are focused on the mining of coal and the extraction of oil, gas, and brine to supply fuels and raw materials for the chemical plants.

Transportation facilities are well developed. Railroads, highways, and pipe lines carry the bulk of the trade; river transport, although important in the early days, is now little used except for a small barge traffic in lumber, coal, sand, and gravel.

The almost phenomenal growth of the chemical industry along the Kanawha since 1914 is reflected in the pattern of population distribution and trends. Most of the upper valley now lies within the density area of 200 to 400 persons to a square mile (Robert L. Britton: Population Distribution in West Virginia, *ibid.*, Vol. 20, 1944, pp. 31–36) and is expected to reach the 400 level in the near future. Charleston, the state capital and the largest city of the valley, had a population of nearly 68,000 at the 1940 census, an increase of some 12.5 per cent over the preceding census. Its function as a transportation center and retail distributing point for the industrial area will doubtless ensure its continued growth.

SOUTH AMERICA

VOLCANIC ACTIVITY AND GLACIAL RETREAT IN PATAGONIA. In Patagonia and Tierra del Fuego there are extensive postglacial deposits of pyroclastic material carried eastward from the volcanoes of the Andes by the prevailing westerly winds. To judge from the thickness of the deposits, the postglacial volcanic eruptions here were highly explosive and rank among the most violent known. As far as 50 to 70 kilometers east of the source volcanoes the fragmental material is 0.5 meter to 2 meters thick. Similar material from the eruption of Katmai in 1912 accumulated to a depth of only 0.5 meter at a distance of 40 kilometers.

Because the material came from many different volcanoes, the number and thickness of the deposits and their physical and chemical characteristics vary from place to place. For the region as a whole, however, there are, in general, four layers of volcanic fragments (five in one area). Study of the pollen in intervening layers shows that, although the eruptions occurred at somewhat different times in different places, they were more or less contemporaneous. That is, volcanic activity in Patagonia in postglacial time has had a definite periodicity, with four great periods of eruption.

Martti Salmi (Die postglazialen Eruptionsschichten Patagoniens und Feuerlands, *Annales Acad. Scientiarum Fennicæ*, Ser. A, III. Geol.-Geogr., No. 2, 1941) suggests that the periodicity of the volcanic activity may be related to the retreat of the ice at the close of the last stage of Pleistocene glaciation. It is now understood that magma is not a purely passive substance, extruded only as a result of tectonic movements. It has within it, because of the presence of gases under pressure, potential energy, which, when released, can force the magma upward. The greater the external pressure on the magma, the greater is the maximum possible pressure of the gases. While the Pleistocene glaciers of this region were adding to the weight of the earth's crust, the gas pressure in the underlying magma was able to become very great. When the ice melted and the external pressure was reduced, the internal pressure was strong enough to break through the earth's crust, producing explosive volcanic eruptions. According to dating from pollen grains, the first and most violent eruptions took place in the northern part of the region (40° to 42° S.), in the general vicinity of Lago Nahuel Huapí, where recession of the ice was most rapid. Succeeding eruptions, coming at shorter and shorter intervals, were weaker, more widespread, and more nearly contemporaneous all over Patagonia. Pollen analysis shows that each eruptive period was preceded by a definite climatic optimum, when milder temperatures permitted rapid melting of the ice and consequent release of pressure. When in some one region this release of pressure made possible a volcanic eruption, the resulting disturbance of equilibrium in the magma chamber underground caused eruptions to occur in other places. This accounts for the marked contemporaneity of the eruptions throughout the region.

The very nature of volcanic activity favors its periodic recurrence, entirely aside from any periodicity of external conditions; for as soon as an eruption is completed, gases begin to accumulate again and build up pressure, which will sooner or later cause another eruption. Nor are violently explosive eruptions dependent on the relatively sudden release of pressure caused by glacial retreat; for they occur in regions entirely unaffected by glaciers. Salmi recognizes these weaknesses in his hypothesis. He believes, however, that at least for this region there is definite evidence of a correlation between glacial retreat and volcanic activity.

THE CLIMATE OF PUNTA ARENAS. Meteorologically, the southernmost tip of South America is a region of unusual interest, but to date little has been published on its weather. The more gratifying therefore is the recent publication of the Observatorio Meteorológico "José Fagnano" summarizing observations of temperature, precipitation, humidity, cloudiness, insolation, evaporation, barometric pressure, and winds for a 21-year period (José Re: El clima de Punta Arenas: 21 años de observaciones meteorológicas, 1919–1940, Punta Arenas, 1945).

Examination of the tabulated and graphed temperature data indicates a cool summer (mean temperature for January, the warmest month, 52.5° F.) and a relatively mild winter (mean temperature for July, the coldest month, 36.1° F.). The average annual precipitation

for the period was 16.1 inches, and the regime shows a late fall maximum (April, May, June), a dry spring (September, October, November), and a secondary maximum in summer (December and January). Relative humidity is high throughout the year, ranging from an average of 63 per cent in November to an average of 80 per cent in June. Cloudiness is also high: December is the cloudiest month, with an average of 7.55 of cloud cover; July, the least cloudy month, has an average of 6.07.

Frequent and strong winds are a well-known characteristic of the climate. About 90 per cent of the winds blow from the west and southwest; those from the west are more frequent, but those from the southwest are both stronger and colder. Velocities sometimes reach as much as 80 miles an hour, especially at the equinoxes. The forecasting of storms is difficult, as a Chilean naval officer notes (Julio Santibañez Escobar: Notes on the Meteorology of Patagonia and Tierra del Fuego, *Bull. Amer. Meteorol. Soc.*, Vol. 21, 1940, pp. 71–75): "The changes in weather in Tierra del Fuego, the Strait of Magellan, and Patagonia are not always in accordance with the oscillations of the barometer, for there are times when the pressure rises or falls considerably above or below the median with continued clear weather with calms or breezes while at other times winds develop in complete disagreement with these oscillations; and . . . the changes in wind are not always foretold in advance by the barometer, as is the case in other latitudes, but occur in an enormous majority of cases in conjunction with the barometric oscillations."

EUROPE

EFFECTS OF THE WAR ON THE AGRICULTURE OF THE NETHERLANDS. Many of the effects of war on a country subjected to military operations can never be calculated. However, recently published figures on the material land damage in the Netherlands make clear the enormous amount of time, effort, and money that will be necessary to restore the agricultural economy to anything like a normal base (J. P. van Aartsen: Consequences of the War on Agriculture in the Netherlands, *Internatl. Rev. of Agric.*, Vol. 37, 1946, pp. 5S–34S, 49S–70S, and 108S–123S). Of the total area of agricultural land, including meadows and orchards, about 10 per cent suffered direct military damage: some 190,500 acres were inundated with salt water, and 349,460 acres with fresh water; and 86,500 acres more were either mined or pre-empted for airports and fortifications. The total monetary loss in agriculture, horticulture, and silviculture is estimated to be about 825 million florins ($453,750,000 on the 1938 exchange rate).

The entire character of agricultural production has undergone a forced change. Before the war, livestock and dairy products provided the bulk of farm wealth; flowers, bulbs, and other horticultural specialties constituted another valuable source of income. Feed and fertilizers were imported in large quantities. During the war, with imports shut off and a sizable area of pasture and meadowland necessarily converted to food crops, the livestock industry suffered greatly. Despite the serious reduction in the cattle population milk production was kept at a remarkably high level. Hogs, sheep, and poultry also decreased sharply in number, but horse breeding, owing to the increased demand caused by the lack of motor transport, was accelerated. The shifting pattern of agriculture may be seen from the land-use data given in the report. The area in field crops expanded from 2,296,609 acres in 1939 to 2,790,207 acres in 1943, an increase of about 21 per cent; the area in vegetables and fruit increased from 112,936 acres to 179,438 acres in the same period, or about 59 per cent; the

area in permanent meadow shrank from 3,313,578 acres in 1939 to 2,826,262 acres in 1943, a decrease of slightly more than 15 per cent.

Unquestionably, a serious situation will obtain for a number of years. Although prices of all farm products are high as a consequence of their scarcity, the costs of production are higher still. "Labour is scarce and wages are high; fertilizers, insecticides and fungicides, concentrated feeding-stuffs, implements and machinery, are all scarce and expensive. Soils have been exhausted during a series of years and the small quantities of artificial fertilizer available will not re-establish the old fertility, so that crops again will give relatively small yields."

As Sir E. John Russell has pointed out (Small Farmers and Peasants of Europe before and after the War, *Geogr. Rev.*, Vol. 35, 1945, pp. 1–11), it is essential that agricultural reconstruction in all the devastated countries be "carefully planned so as to make up by clear direction for some of the serious losses of productive capacity."

THE CLIMATE OF THE NETHERLANDS DURING THE LAST TWO AND A HALF CENTURIES. In a publication with this title (the author's doctoral thesis) A. Labrijn presents a critical investigation of the materials available on the subject, especially the older ones, and a study of the climatic changes in the Netherlands 1700–1944 (*Kon. Nederl. Meteorol. Inst.* [*Publ.*] *No. 102: Mededeelingen en Verhandelingen 49,* 1945; in Dutch, with summary in English). The second part is of special interest for Americans.

Winter temperatures showed a decrease from 1705 to 1790, which was followed by a long period—1790–1940—of higher temperatures, except for a short drop after 1870. After 1940 another decrease seems to have set in. During the period 1781–1820 the average winter temperature at Utrecht was 0.3° C.; during 1901–1940 it was 2.2°, an increase of almost 2°. In contrast with the noticeable change in the winter temperature, the corresponding difference in the July temperature was only 0.1°. Because the control of winter climate is essentially cyclonic, the reason for the changes must be sought in a shift of the cyclonic storm tracks: warmer winters would mean a shift of those tracks to the north. A study of the amplitudes of temperature as an indication of increase or decrease of the maritime character of the climate gives the following results: 1700–1770, decrease of maritime character; 1770–1790, transition; 1790–1920, increase of maritime character; 1920–1925, transition; 1925–, decrease.

Precipitation data are available from 1735. The yearly amounts remained fairly constant at 770 millimeters up to 1775, after which there was a sharp drop of 120 millimeters to 1805. Increase followed up to 1880 (with a slight drop in 1850); the amount in 1880 was 800 millimeters, a gradual rise of 150 millimeters since 1805. After 1880 the precipitation started to decrease in amount (60–70 mm.). However, in later years a new rise has been recognizable. A comparison of summer and winter conditions shows greater fluctuation for the amounts of summer precipitation; the curves are fairly similar, but there is a retardation for the summer. The lowest point of the dry period, for instance, was in 1790 for the winter precipitation and in 1810–1815 for the summer precipitation; the peak was in 1830 for the winter and in 1840 for the summer.

As regards wind, during the period 1700–1800 a veering was recognizable, but after that it backed over 20°–25° or 15° per century. There was a definite increase of both northerly and southerly winds, though, of course, the southwest and west winds remained dominant. The percentage of northerly wind increased from 7.0 in 1761–1790 to 9.6 in 1911–1940; of

southerly wind from 9.6 to 13.9; the dominant southwest wind decreased from 24.1 to 22.2 per cent. Pressure conditions remained rather constant during the period for which observations are available; the difference for 30-year periods ranges only from 760.9 to 761.5.

On the whole, it is clear that for the American climatologist interested in climatic fluctuations this study of the climate of the Netherlands is of great value and fills a gap in the knowledge of climatic cycles in Western Europe.—S. VAN VALKENBURG

ASIA

MONGOLIAN PLACE NAMES. Geographical nomenclature is based on the appellative designations found in every language—river, mountain, pass, lake, and so on. In the Mongolian language this nomenclature is unusually detailed, as we learn from a valuable monograph by V. A. Kazakyevich published in Russian some years ago and recently translated (Modern Mongolian Toponymy, *Acad. of Sci. of the Soviet Union, Research Committee of the Mongolian Peoples' Republic, Works of the Mongolian Commission No. 13,* Leningrad, 1934, translated by F. D. Lessing, Berkeley, Calif., 1944). This study, which contains a glossary of several hundred generic terms, is the basic work on modern Mongolian toponymy.

In his "Mongol Journeys" Owen Lattimore observes: "There is ... such an accurate terminology for different kinds of hills, ridges, plains, lakes, pools, streams and springs that you can get directions taking you across many miles of vague country without a mistake." Such detailed geographical toponymy is explained by Kazakyevich as a corollary of a nomad cattle-raising economy dependent on close familiarity with the details of the grazing grounds and watering places and all the small peculiarities of the areas where the tribes migrate. The richly varied terminology is further enhanced by descriptive terms and allusive phrases reflecting the social structure and religious thought of the people.

The familiar term *gobi* usually evokes the popular idea of a desert as a sandy, barren, waterless waste. "What contributed to this conception was the 'adventure' literature of Central Asia which paid too much attention to the exotic character of the desert. As a matter of fact such a conception does not correspond at all to the meaning given by the Mongols to the word *gobi*." To them it represents a sterile plain with a hard surface of coarse sand and fine rubble supporting a sparse growth of tough grass and woody plants and with infrequent water holes or small springs. It may comprise sand dunes (*mangkhan*), or naked black plain (*khara gobi*), or the sun-dried surface of a salt marsh (*dabasa*), or a poor steppeland of sandy hummocks and gobi sage (*eren tala*).

Wells and springs often take their names from the vegetation. Most frequent are the *jagh* (saxaul), *deresen* (feather grass), *khulusun* (reeds), *burgasun* (willow thicket), *toroi* (the wild Asiatic poplar, *toghrak* in the Turkic-speaking areas, the *wu-t'ung* tree of the Chinese), and *sukhai* (tamarisk). In the khara gobi, between Etsin Gol and the Sinkiang border, the name Jagh copiously adorns the maps, appearing alone and in many compounds, such as Shara Jagh (yellow saxaul), Khara Jagh (black, or dead, saxaul), and Dolon Shara Jaghin Sume (temple of the seven yellow saxauls).

The presence of trees frequently calls forth a numerical qualifier, and we find Durban Modo (four trees), or Yesun Modo (nine trees), or Dzuun Modo (a small grove, literally "one hundred trees"), and also Olon Modo (many trees). If the trees are aspens, for instance, the place will be more explicitly designated as Ulyaasutai (having aspens, or where there are aspens), *-tai* or *-tu* (*-to, -ta*) being the suffix added to a substantive to denote possession or

concomitance. This form is used in thousands of Mongolian place names; for example, Khujirtu (having salt, or where there is salt), Mogoito (having snakes), Shabartai (having mud), and Khara Yamata (where there are black goats).

Names are often compounded with adjectives of color. Tsagan Tologoi (white head, or summit), Boro Obo (gray obo), Ulan Nur (red lake), and Koko Ula (blue mountain) occur frequently. *Yekhe* and *baga*, "big" and "little" respectively, may qualify almost any name, and such descriptive designations as Gashun Nur (bitter lake), Gun Khuduk (deep well), Khuten Gol (cold river), and Arshan (hot springs) are familiar in any language.

Names of animals—*khoni* (sheep), *mori* (horses), *ukher* (cattle), *yingen* (the female camel), and others—reflect the important part they play in the lives of the herdsmen tribes of Inner Mongolia. Deeper in Central Asia the list increases with the wider variations in climate and terrain. *Bulgan* (sables), *khalun* (otters), and *une* (ermine) appear in the names of rivers, *dzeren* (antelope), *teke* (ibex), *argali* (*Ovis argali*), *bogho* (deer), and many others in the land names.

A brief digression into the rules of grammar gives the key to the names of the innumerable temples and monasteries—*sume*, *khuree*, *khit*, and *dzuu*—which mark every more or less permanent settlement of the Mongols. The genitive suffix *-in* or *-i* is added to substantives to give a possessive adjectival meaning, as in the Latin genitive case. Lamain Sume is the "Temple of the Lamas"; Khadain Sume, the "Temple of the Steep Rock" (a well-known Swedish mission north of Kalgan); Shirete Gegeni Sume, "Temple of the Enthroned Holiness."

In mountain areas one must be prepared to follow the steppe nomads into a world of magic and mysticism. One of the characteristic ceremonies of the primitive Mongol religion was the worship of mountain spirits, part of the general cult rendered to the *Koko Mongkha Tengri*, or "Eternal Blue Sky," the supreme deity that watched over the Mongol race. From the worship of mountain spirits there followed naturally a superstitious regard for, and often fear of, the mountain itself, which was transferred to its name. A study of the taboo appearing in such cases has been made by Kazakyevich; he explains the name Khairkhen, which frequently appears as an appellation of mountains in the Mongolian areas: "If in a certain area we have a recurrence of calamities, as epidemics or cattle plagues, and neither a re-naming of the mountain nor its propitiation by offerings are of any avail then they cease altogether to pronounce the name of the mountain, calling it simply *xäèrxă* [*khairkhen*], 'darling, friendly,' because, according to wide-spread belief, a kindly form of address cannot provoke the ire of the mountain."

The highest honorific title, *Bogdo*, "Lord," or "Holy One," which belongs only to the Living Buddhas, is also given frequently to mountains. The names of separate summits, *tologoi*, are often derived from the lama faith, such as Bandin Tologoi, from *Bandi*, a term for a lower rank of the clergy, or Erdeni Tologoi, referring to the "jewels" of Buddhism (the Buddha, *Burkhan;* the doctrine, *Nom;* and the order of monks, *Bursang Khuvarak*).

Spirit worship is evident everywhere in another form in the innumerable "obos" that crown the hills and mark the passes of the Mongolian areas. These are pyramids of heaped stones, or stacked-up boughs of trees, by means of which contact is made with the local spirits, the *gajarin ejen*, who are believed to be the real lords of the earth, on which men are but trespassers.

The glossary of Kazakyevich's work is based on the Khalkha dialect, which is recognized

as standard among the modern dialects. As a result of recent political events, however, Buryat, with its new terms for new ideas, mostly patterned after the Russian, is increasingly infiltrating, creating a new idiom, and is seemingly destined to become the literary medium for all the Mongolian tribes.—DOROTHY TROXEL

REGIONAL DIAGRAMS OF OMEISHAN. It is interesting to see the regional diagram devised by Isaiah Bowman for illustration of the Peruvian Andes (The Country of the Shepherds, *Geogr. Rev.*, Vol. 1, 1916, pp. 419–442) transferred to western China, as Shu-tan Lee does in "The Making of Regional Diagrams in Omei-Shan" (*Journ. Geogr. Soc. of China*, Vol. 7, 1940; in Chinese, with summary in English, pp. 13–17). This, however, is not the first application of the method to that part of the world. P. H. Stevenson used an excellent regional diagram and cross section of the Ching Chi Valley in writing on the Chinese-Tibetan borderland (*Geogr. Rev.*, Vol. 22, 1932, pp. 599–616, Figs. 5 and 6). As Mr. Lee puts it, "the regional diagraming method is one of the most practical for travelling over such an unsurveyed country as the inland China, especially in mountainous regions." Omeishan, one of China's sacred mountains, is in western Szechwan. Its altitude is more than 10,000 feet, and it is deeply dissected. Broad valleys found on the softer rocks are important for settlement and cultivation. Mr. Lee illustrates two of them.

In connection with Omeishan, reference may be made to the article in the June, 1946, number of the *Journal af Meteorology* "Some Remarks on the Climate of Omeishan" by Huan-yong Hu, author of "A Geographical Sketch of Kiangsu Province" in this number of the *Geographical Review*.

THE CLIMATE OF AFGHANISTAN. The establishment of nine meteorological stations in Afghanistan between 1939 and 1943 comes as good news to climatologists and geographers, since before 1939 the observatory at Kabul had furnished the only climatic data in the entire country. Now, in spite of the short span of the records, Dr. Edward Stenz, technical director of the new Afghan Meteorological Service, is able to make an interesting contribution to our meager knowledge of Afghanistan's climate (The Climate of Afghanistan: Its Aridity, Dryness and Divisions, Polish Institute of Arts and Sciences in America, New York, 1946). On the basis of the recent Afghan data and records of stations in neighboring areas, Dr. Stenz has worked out a climatic-regions map of the country (using the decimal classification of Gorczyński) that represents a considerable refinement of the generalized region appearing on the world climatic maps of De Martonne, Köppen, Thornthwaite, Trewartha, and others.

Also of interest is the author's "dryness index," based on the ratio of evaporation capacity to average precipitation, evaporation capacity being calculated by formula from temperature, humidity, and wind-velocity data. Use of the index makes possible a differentiation of arid climates. "The greater the evaporation (due to high temperature, low humidity or wind action), the higher the dryness index; the scarcer the rainfall, the greater the dryness index as well. In this way different values of this ratio may determine different kinds of arid climates, because it is evident that only to a certain excess of evaporation over precipitation the steppe vegetation may exist; if this excess exceeds a certain limit, the steppe vegetation ceases to exist and the region becomes a desert." A table listing the dryness indices for stations in Afghanistan and selected comparable stations in Europe, Australia, North America, and elsewhere in southwestern Asia is included.

SOME GEOGRAPHICAL FACTORS IN THE PALESTINE PROBLEM. Attention is called to an article with this title by Dr. E. C. Willatts (*Geogr. Journ.*, Vol. 108, pp. 146–179, published April, 1947), which reached the Society too late for inclusion in Dr. Fisher's bibliographical discussion, "Unity and Diversity in the Middle East," published in our July number. Dr. Willatts accompanied the Anglo-American Committee to Palestine (1946). His presentation is a model of its kind. The cartographical illustrations underline the geographical realities of the problem—a small country with marked physical disunity and closely interrelated human and economic associations.

POLAR REGIONS

THE EAST GREENLAND ICE. The greatest of the world's ice streams is that which is carried down the coast of Greenland by the East Greenland Current and, reinforced locally by land ice, at times of maximum extension reaches and rounds Cape Farewell to swing up the southwest coast. The vagaries of this ice stream have been the object of at least desultory observation by seamen, explorers, and scientists for centuries, and an increasingly voluminous literature has been accumulating concerning its character. In "The East Greenland Ice" (*Meddelelser om Grønland,* Vol. 130, No. 3, 1945) Lauge Koch painstakingly draws together the many threads of knowledge concerning this ice stream. Not only does Koch provide the definitive summarization of all available data on the stream itself, but from archeological and historical investigations he arrives at certain conclusions on the relationships between its behavior and past fluctuations of climate.

The data on which Koch's work is based are generally fairly extensive for the years of the twentieth century. Besides his own far-reaching observations over the last 25 years and those of a host of other scientific investigators, he has utilized the ice-chart records of the Danish Meteorological Institute. This source, although it has definite limitations, does provide a usable summary of known ice conditions in North Atlantic waters during the years 1898–1938. In projecting the study farther back for more than ten centuries, Koch naturally found the evidence becoming increasingly fragmentary and difficult to evaluate. The wide range of the materials from which these older data have been derived required a constant sifting of the bases of reliability. As the conscientious author remarks: "Nobody knows better than myself the uncertainty of much of the material utilised in the present paper; even information on the ice conditions within the present century should often be employed with great criticism."

Dr. Koch reaches the following general conclusions: In the years 800–1200 "there was hardly any ice"; in the years 1200–1400 "there was somewhat more." In 1400–1600 the ice decreased in amount; in the 300 years between 1600 and 1900 "there were exceptionally large quantities of ice." During the most recent period, 1920–1930, "there was hardly any ice."

Dr. Koch's great interest in scrutinizing the history of the East Greenland Ice for evidences of climatic variations dates from the year 1925, when he heard Fridtjof Nansen advance the theory that "no fluctuations in the climate had taken place since the Middle Ages." Referring to that occasion, Dr. Koch says: "Although the subject was new to me, there seemed to me to be some obscure points in his argumentation. Now, twenty years later, I have arrived at quite different views from those then advocated by Nansen." Koch's present conclusions are cautiously but significantly expressed as follows: "The temperature fluctuations ascertained

in historic times do not amount to very many degrees, but in regions in which the possibilities for existence approach the limit, small changes in the climate are so significant that they have been, and still are, of the greatest importance to plants, animals, and human beings."

It is reported that Koch's work is to be supplemented by two additional papers, prepared by his colleagues E. Hovmøller and A. Kiilerich. One of these is to deal specifically with meteorology, the other with hydrography.—JOHN C. WEAVER

WORLD AS A WHOLE AND LARGER PARTS

THE BLACK TENT. In a scholarly monograph that reflects a prodigious amount of documentary research C. G. Feilberg traces the form, distribution, and culture history of the so-called "black tent" in the Old World (La tente noire, *Nationalmuseets Skrifter,* Etnografisk Række II, Copenhagen, 1944). A generalized distribution map shows that the zone in which the black tent is common lies between 25° and 40° N. and that the tent is the predominant (or in some places the sole) type of habitation in the area between 30° and 35° N.

Although the author believes that the decisive factor governing distribution of the tent is to be found in the cultural history of the nomadic peoples whose customary dwelling it is, he has nevertheless pointed out some interesting geographical relationships. For instance, comparison of the distribution map with a map of average annual precipitation shows that in general the black tent is found in areas having less than 500 millimeters of rainfall a year. There are exceptions, however; in parts of central Morocco, in Anatolia and Armenia, and in southeastern Europe tents are common in regions receiving considerably more than 500 millimeters. Similarly, there are certain inhabited areas receiving less than 500 millimeters where the tent is not common—southern Arabia and parts of Central Asia, for example. Comparison with De Martonne's map of cloudiness indicates, again in general, that the tent is found in regions with a cloudiness of less than 4, and more particularly of less than 3. From these two comparisons, an obvious fact stands out: the primary function of the black tent is not to serve as a shelter against rain, but as a protection from the sun. The dark color casts deep shade, and the loosely woven, porous fabric of hair and wool permits a fair circulation of air. A third correlation is that between the distribution of the black tent and Vahl's vegetation map. Here it is found that the tent predominates in the area of the *steppes d'arbustes* that fringe the subtropical deserts and form a transition between desert and maquis.

The black tent, clearly, is the logical kind of habitation for the regions in which it predominates—quickly erected and as quickly struck, easily transported, utilizing materials readily available to pastoral peoples, and offering protection against heat in the summer and cold in the winter.

PHYSICAL GEOGRAPHY

AERONAUTICAL CHARTS AND THE OBLIQUE MERCATOR PROJECTION. Almost any oblique cylindrical projection is well fitted for a map of a great-circle route if it is tangent to this route, since the distortion will be negligible in the neighborhood of the great circle. The oblique Mercator has the added advantage of being conformal, so that, even at some distance from the center line, shapes are well preserved and directions near any point are correct.

Recently, in order to meet the requirements of air carriers operating over the North Atlantic and using high-speed, high-altitude, long-range aircraft, the United States Coast

and Geodetic Survey published an aeronautical chart (No. 2201) on the oblique Mercator projection centered on the great-circle route between Chicago, Ill., and Gander, Newfoundland. The chart has many excellent and unusual features.

The scale on the center great-circle route is 1 : 2,000,000, and this route is shown diagonally across a rectangular map having dimensions of about 26 by 54 inches, an arrangement that enables all other international air routes originating in the United States and extending to transoceanic take-off points in Newfoundland and Labrador to be shown. The maximum increase in scale is less than 1 per cent at 500 miles from the tangent great circle, and all straight lines closely approximate great circles, so that for practical purposes corrections are not required for radio bearings.

In spite of the relatively small scale, the basic information is given in sufficient detail, particularly in respect to the drainage pattern, and seems to have been compiled very carefully. The chart is reproduced in eight colors, with the cultural detail mostly in black, though the built-up areas of the larger cities are in orange. The highways, state boundaries, and state names have been reproduced through a half-tone screen, and the drainage names are in dark blue. Contours have been eliminated, but hypsometric tints have been retained and, with a critical selection of spot elevations, afford an adequate picture of relief. By these means the map has been made easy to read and remarkably clean in appearance, and at the same time sufficient emphasis is given to the aeronautical data.

All aeronautical symbols conform to ICAO (International Civil Aviation Organization) standards. Isogonic data are for the 1947 period. All radio navigational aids are indicated, but without frequencies or directional characteristics. Airports have been selected with reference to their use by heavy aircraft and their strategic location. All aeronautical lights and important marine lights are shown.

Two other features of the chart are of considerable interest. For certain areas covered, the topographical information available is of doubtful accuracy and incomplete. In such cases it was impractical to show relief by hypsometric tints, and a buff land tint has been substituted. As a consequence, these danger areas stand out conspicuously.

The other innovation, which, it is understood, was requested by the aircraft operators but which is not yet in a satisfactory cartographical form, is that within each area formed by 2° of latitude and 3° of longitude the maximum elevation if known is indicated by enlarged type in the lower right-hand corner of the rectangle.

The chart sells at the remarkably low price of 25 cents.

SUBMERGED PRE-CAMBRIAN SURFACES OF MARINE PLANATION. During the last half a century the hypothesis of peneplanation by subaerial denudation, brilliantly developed by Powell, Dutton, and Davis, has dominated the thinking of geologists and geographers, more or less to the exclusion of the earlier English hypothesis of marine planation. It is, however, to the latter that H. H. Hess has turned for an explanation of certain odd submerged flat-topped peaks in the Pacific Basin (Drowned Ancient Islands of the Pacific Basin, *Amer. Journ. of Sci.*, Vol. 244, 1946, pp. 772–791). Recent soundings made by the Hydrographic Office, United States Navy, between Hawaii and the Marianas have discovered some 160 of these features, called "guyots" by Hess after the nineteenth-century geographer Arnold Guyot. They rise 9 to 12 thousand feet above the ocean floor and have flat summits 3 to 6 thousand feet below sea level and a couple of miles to 35 miles in diameter. Usually a gently sloping shelf a mile or two wide borders the flat summit. A few of the summits are

hummocky, probably because of the accumulation of fine sediments. The flatness of most of the guyots, however, suggests that they have been swept clean of sediments, perhaps by the occasional stirring of these deep waters by tsunamis.

Hess suggests that the guyots are volcanic peaks. While subaerial erosion was reducing their surfaces to low relief, marine abrasion was developing gently sloping submarine platforms around them to depths of about 600 feet. Finally marine planation completely beveled each island, producing a level summit at a depth of about 180 feet, surrounded by the still deeper slope of the marginal shelf.

Completion of this cycle of marine planation would require long-continued stability of the earth's crust. Doubt as to the probability of such continuous stability has been one of the chief reasons for objection to the hypothesis of marine peneplanation. In this case, however, there is no need for doubt; for the Pacific Basin proper, except for its extremely unstable margins, is now, Hess believes, and probably always has been, a very stable region tectonically. While volcanism is active, volcanic islands will, of course, be subject to frequent vertical movements and are in this sense unstable. Even after the volcanism has died out, and in the absence of tectonic movement, there will still be a slow apparent sinking of oceanic islands; for the accumulation of sediment on the ocean floor displaces sea level upward. (Isostatic adjustments between ocean basins and continents, accompanying the sedimentation, may permit sea level to remain more or less the same with reference to the continents.) Guyots, formed as outlined above, with their flat summits originally at depths of about 180 feet, would therefore "sink" lower and lower, the older ones sinking the deepest, unless at the same time their surfaces were being built up by reef-forming organisms. Such organisms have existed since Cambrian time. Inevitably, therefore, guyots formed from Cambrian time on must have become atolls or banks, the reefs growing upward as the volcanic bases sank, relatively speaking. Since the guyots described by Hess have been able to sink to depths of three to six thousand feet, they must have been formed and submerged below the depths in which reef-forming organisms can live before such organisms were present—that is, in pre-Cambrian time. Under subaerial conditions the preservation of pre-Cambrian erosion surfaces largely unaltered since their formation by either erosion or deposition would be unthinkable. If, however, these ancient surfaces were submerged to depths of several thousand feet below sea level, as Hess postulates, and kept there by freedom from tectonic movements, their preservation becomes an interesting possibility.

GEOGRAPHICAL NEWS

INTERNATIONAL CONFERENCE ON THE SOILS OF THE MEDITERRANEAN. In May, 1947, the French Association for the Study of Soils was host at a successful international conference on the soils of the Mediterranean. Proceedings opened on May 1 at Montpellier, seat of the best-known agricultural college in France. Three days of presentation and discussion of papers were interspersed with one full day and two half days of field trips by bus to study soil profiles and the natural vegetation and land-use conditions in the mountains and along the piedmont. Specially prepared pamphlets and booklets containing descriptions and analyses of the profiles studied in the field were of material help.

From Montpellier the members of the conference went by bus to Marseille (two days), with a stopover at the historic city of Nîmes; at Marseille they took ship for Algiers. Three days of conferences there were alternated with three days of field trips by bus. Special at-

tention was given to terra rossa, reclaimed marshes, and the reforestation of steep mountain lands with olive, almond, and fig trees. It may be remarked that where observed soil profiles could not be reconciled with prevailing climatic and other factors, the delegates from the Continent were inclined to fall back on the concept of "paleo" or "fossil" profiles—development under a different climate from that prevailing at the present time. In Algiers we experienced a sirocco, with its accompanying dustfall, that will long be remembered. It was a striking demonstration of how soil profiles can be modified by the addition of fresh mineral materials from considerable distances.

On May 15 we left Algiers for Oran, with a stop at Relizane, where several observations were made of soil profiles with calcareous horizons. On the following day the party left by bus for the study of saline soils and soil drainage in the Perrégaux-St.-Denis-du-Sig valley to the southeast. A long trip inland, past Sidi-bel-Abbès of Foreign Legion fame, brought us to the ancient town of Tlemcen in the Atlas Mountains. Some of the delegates made a special trip through the mountains, where cork-oak forests grow on noncalcareous soils, to see the new Beni-Bahdel Dam for storage of water for Oran, more than a hundred miles distant, and for irrigation and electric power. The entire party made a 155-mile trip to examine the calcareous hardpan soils of the steppe along the northern edge of the Sahara. Unusually heavy rains a few days earlier made a long detour necessary and prevented us from reaching the southernmost profile pit on the steppe.

On the return to Oran the party examined the soils of the coastal hills and valleys between Tlemcen and Nemours. Some of the steepest slopes about Nemours have recently been terraced and planted to olives, figs, and almonds, in the hope of stopping the erosion that now threatens to silt up the harbor.

On the 19th the final session of the conference was held at Oran. A number of the leading delegates endeavored to summarize what had been seen and discussed in Algeria: the principal types of soils and the soil research being carried on; the problems stemming from land utilization in the colony.

The location and nature of the soil profiles studied and the training and interests of those leading the discussions in the field illustrated particularly interestingly the contrasts between the points of view of the scientists who demonstrated the soils in France and in North Africa. In France, where land use and empirical methods have long been stabilized, the problems of the origin and development of terra rossa and other soils occupy much of the attention of the naturalists, phytogeographers, agronomists, chemists, and geologists—there seem to be no French pedologists as such. Had there been a pressing demand from the agricultural interests for soil surveys, it seems likely that soil maps would have been available to clarify relationships and development. As it was, many of the profiles demonstrated were of nonagricultural soils; in fact, the terra rossa profiles were often those exposed in clefts in the limestone, as in quarry faces in upland locations where there was almost no soil on the rock. Northern Algeria, in contrast, is a comparatively recent frontier, along which French colonists have been struggling against greater odds: less familiar agricultural conditions, a more rigorous climate and often inadequate rainfall, a lack of good irrigation water, saline and poorly drained soils, and the pressure of the population and livestock of the native tribes. In the agricultural and forestry services of the colony younger, alert men, more aware of the practical problems of soils, are actively searching for the answers. In Algeria they had had numerous large profile pits dug in agricultural and pasture soils, and they took an important part in the discussions. Terra rossa again came in for considerable attention: G. Gaucher, in what

some considered one of the best papers of the entire conference, said, in effect, that practically nothing of significance can yet be offered as to how this widespread kind of soil profile has developed.

Officially represented at the conference were Belgium, Great Britain, Norway, Palestine, Portugal, Sweden, Switzerland, the United States (three delegates: Charles E. Kellogg, Jacob S. Joffe, and the writer), and the United Nations (Jean Gottmann); and there was, of course, a large French representation. After the long isolation of the war years the opportunity of meeting old colleagues and making new acquaintances was doubly welcome. Special thanks must be given to all, individuals and organizations, who contributed to the success of the conference in the face of many difficulties; words are insufficient to express our appreciation for the kindness and hospitality we met on every hand. MM. Demolon, Boischot, Hedin, Emberger, Aubert, Bordas, and Roseau, and many others, deserve great credit for their vision, courage, hard work, and generosity.—ROBERT L. PENDLETON

A NEW CANADIAN PERIODICAL. The growing family of geographical periodicals has acquired another welcome new member with the appearance in March, 1947, of the *Revue Canadienne de Géographie*, organ of the Société de Géographie de Montréal. The first number presents only one article, a study by Benoît Brouillette of the regional economy of the north shore of the St. Lawrence (to be continued in a later number), but there are sections devoted to critical book reviews, geographical news notes, and activities of the society. The new journal, to be published quarterly, replaces the *Bulletin de Géographie de Québec et de Montréal*, which ceased publication in 1944.

AN APPEAL FROM THE GLOBE-MUSEUM IN VIENNA. The Globe-Museum in Vienna, owned partly by the Austrian government, and under the direction of Robert Haardt, is interested in obtaining data on early globes. The purpose is to compile a world catalogue of old globes, up to 1850, and full descriptions are desired, as follows: (1) name of collector or library owning the globe; (2) author of the globe; (3) type, whether terrestrial (T), celestial (C), or armillary sphere (A); (4) date; (5) full title; (6) diameter (in centimeters); (7) conservation and mounting.

If a photograph or illustration of the globe is available, the Globe-Museum would appreciate receiving a copy: for the Museum collects not only old globes but copies and illustrations, and also historicogeographical literature.

In 1921 the Hispanic Society of America issued a two-volume book by the late Dr. Edward Luther Stevenson, "Terrestrial and Celestial Globes: Their History and Construction." Many additional items have come to light since 1921, and Mr. Haardt would appreciate it if our readers would send in notices of such material, either through the Society or directly to him. Address Dipl.-Ing. Robert Haardt, IV. Gusshausstrasse 20, Vienna 50, Austria.

THE POPULATION OF THE SOVIET UNION: History and Prospects. By FRANK LORIMER. xiv and 289 pp.; maps, diagrs., bibliogr., index. *League of Nations Publs., II. Economic and Financial, 1946.II.A.3.* Economic, Financial and Transit Department, League of Nations, Geneva (agent in the United States: Columbia University Press, International Documents Service, New York City), 1946. $4.00. 10¾ x 8¼ inches.

In an author's preface, Professor Lorimer remarks that "the student of the population of the Union of Soviet Socialist Republics has at his disposal a large body of demographic and related material." For those not conversant with Russian, however, much of that material was to all practical intents unavailable until the appearance of this book. Here Professor Lorimer, with the assistants whose help he generously acknowledges, has presented in digested but ample form the essential data from the three nation-wide censuses of 1897, 1926, and 1939, the only such censuses of which the results have been published. More than this, Professor Lorimer has performed expert and yeoman service in bridging the discontinuities between the successive censuses, as in matters of definition and territorial division; and by the critical use of vital statistics for the areas and years for which these are available he has provided working hypotheses to fill some large gaps in the statistical information given in the censuses. As he explains, he has "been forced to resort to devious and often doubtful interpolations and inferences in treating population changes in the years intervening between 1926 and 1939, and in estimating recent trends. . . . Information on economic and social conditions in both the Imperial and Soviet periods, required for the interpretation of population changes, is abundant but at many points incomplete or ambiguous. The major characteristics and trends of the Soviet population, nevertheless, emerge with considerable clarity from various items of information considered in their mutual relations. The broad outlines of the account have greater validity than many of its constituent items."

In plan the book consists of four parts. The first may be said to provide a historical background for the 1926 census. The demographic history of the Russian Empire is discussed, and the tumultuous period from 1917 to 1926 is recorded in such quantitative measures as are available. The second part of the study is an analysis of the census of 1926 on a comparative regional basis, dealing with internal migration as indicated by place of birth and place of residence, the ethnic composition, and the economic and cultural characteristics of the population; these regional comparisons are then correlated with those based on the vital statistics. The third part of the book compares the results of the 1926 census with those of the 1939 census as regards occupation and production, demographic data, and internal migration. The final part is concerned with the "Prospects" of the title and with quantitative estimates of population changes during the war and the postwar period.

All this is accompanied by no fewer than 103 statistical tables carefully annotated, 31 figures in the text, 22 tipped-in distributional maps, a comprehensive bibliography of 512 titles, and a sensible index.

Among the distributional maps there are some ingenious examples of statistical cartography. On Plate 17, for instance, color, stipple, and circles of proportional area are combined to present concisely a complex interrelation without the aid of lettering. If one were inclined to quibble, however, he might say of this map that the north-south alignment of the "Study Areas" (pp. 150–151) in Soviet Asia produces a misleading impression: the great northern

areas are colored to indicate the highest rate of increase of urban population, whereas Plate 15 (Growth of Cities) shows no fast-growing town there and Plate 14 indicates that urban centers there number but six, each of which has fewer than 50,000 residents. Singly and collectively, these distributional maps invite geographical interpretation. Sometimes the invitation is rather tantalizing; for one may have to go on a treasure hunt for references to the data on which the map is based.

Throughout the study Professor Lorimer has accepted the censuses in good faith. He finds in the census of 1926, of which the results were published in 56 volumes, evidences of internal consistency that suggest a genuine count. The census of 1939, published in summary only, does not provide the same breadth of evidence, but it, too, he sees no good reason to doubt. In the interpretation of the data he seldom goes beyond an orderly presentation, with some necessary reconstruction, of the chronological record and the setting of that record in a reasonable perspective. Able sociologist though he is, Professor Lorimer yet refrains from comment on the changing social values dominant in Russia in the years under discussion. His is rather an attempt at scientific detachment in reducing to quantitative form the knowable facts in an area that has been too often a ground of contention.

Among the reconstructions, based on inferences drawn from the official records, one of the most striking is his estimate of the cost in human life of the various catastrophes, wars, revolutions, and social changes of the years from 1914 to 1945. "The loss of human lives during these past thirty years," he writes, "counting both excess deaths and deficits of births under abnormal conditions, approaches and may pass fifty million persons." The steps by which he arrived at this figure may be followed on pages 36–43, 133–137, and 181–183. Equally striking, however, is his estimate of the national recuperative power. About 1936 the net reproduction rate was, according to his necessarily rough computations, 1.72 (1.00 marks the simple replacement level). "The figure obtained here (1.72) would indicate an intrinsic natural increase (with natality of 1924 and mortality of 1926–1927) of slightly less than 2 percent a year—or a tendency toward a doubling of the population once every 36 years. It is safe to say that the intrinsic reproductivity of the Soviet population at this time was sufficient to allow an increase of well over 50 percent per generation." The bases for this conclusion and the regional variations in the reproduction rates are documented on pages 87 to 93. He estimates (p. 131) that in 1938 the net reproduction rate fell to about 1.54, and he suggests that the prewar trends might be projected to 1970 on two alternative hypotheses of slackening future growth, one hypothesis allowing for war losses and the other taking no account of them. The broadly based age pyramids that would be expected in each decade under these hypotheses (p. 189) are impressive indeed.

For the understanding of the interrelations between the geography and the demography of the Soviet Union, the great sweep of the Soviet lands is an obstacle. As Professor Lorimer observes in his first chapter, the land area and the total population of the Soviet Union at the time of the 1939 census were closely comparable with those of North and Central America exclusive of the Caribbean islands and Greenland. Yet how many generalizations could safely be made about the lands or the peoples of North and Central America as a single unit? The lands of the Soviet Union are no less diverse and the peoples no less heterogeneous. For this reason, we especially welcome the regional analyses of demographic data in this book, though it may be a long time before Western geographers have the intimacy of local knowledge needed for their just interpretation.

INDIA'S POPULATION: Fact and Policy. By S. CHANDRASEKHAR. 117 pp.; bibliogr., index. The John Day Co. (An Asia Press Book), New York, 1946. $2.00. 9¼ x 6 inches.

POPULATION IN MODERN CHINA. By TA CHEN. ix and 126 pp. The University of Chicago Press, Chicago, 1946. $2.50. 9¾ x 6¾ inches.

POPULATION AND PEACE IN THE PACIFIC. By WARREN S. THOMPSON. 397 pp.; maps, diagrs., bibliogr., index. The University of Chicago Press, Chicago, 1946. $3.75. 9¼ x 6 inches.

As lands of the East follow patterns of Western economic development, populations increase at an alarming rate. If these lands were sparsely settled, if they were rich in available resources, or if there were new lands to which migrants could go, as was in general the situation in Europe in 1800, the problem would not be so grave. But the already crowded areas of Monsoon Asia face today a population explosion that may be catastrophic. It is fortunate, therefore, that demographers are putting before us the essential facts in the situation. Three recent works are noteworthy examples of these important studies.

For India, owing to the efficient operation of the census, there are enough relatively reliable data for good demographic studies. Dr. Chandrasekhar, an Indian who has had American training in demography, has used these data well. He epitomizes the population problem of India as "one of too many births and too many deaths . . . , with the surviving population subsisting on a miserable standard of living." In his discussion of a national population policy he pleads for an organized struggle against "the incredible poverty of the people." He advocates the correction of the imbalance between "extreme overpressure on agriculture and the lack of industrialization," though he warns that industrialization will not "provide the panacea for all of India's economic ills." He argues for a "thorough overhauling and reorganization of the entire economic and social structure of the country" under conditions of political freedom. Unfortunately, his book is lacking in maps and in discussion of differences in demographic conditions within the country. It is to be hoped that some day a good geographic study of India's people will be produced. Such a study might well follow the plan M. W. W. M. Yeatts had anticipated carrying out in 1941. This plan (as noted in his Introduction to the Census of India, 1941, Vol. 1, India, Government of India Press, Simla, 1943) was to include a map showing India's forests, irrigation, and water power and an essay "showing the face of the country as it was and as it might be and the effects of population movements on these possibilities and of the possibilities themselves on population movement of the future."

In contrast with India, China is a country without adequate demographic data. This is well illustrated by the work of one of China's leading demographers, American-trained Ta Chen. It is to be regretted that the modern fashion is for short titles; for this book might better have been titled "Notes on Estimates of China's Population, Together with Census Data from Ten Small Areas within China, Especially Emphasizing One Area, the Kunming Lake Region." The sample census materials used cover only 0.8 per cent of the total population of the country. The small areas, several of them counties, are located for the most part near Nanking, Chengtu, and Kunming. They are, therefore, "not representative of the total population of China," but they are the only "relatively trustworthy" material available, and Dr. Chen uses them to the full. His study follows the usual pattern of demographic reports and is enhanced by 65 tables. The book has no maps, but the geographic setting of each of the ten areas is given. In one case this setting is confusing: in discussing the Kunming

Lake region the author remarks on page 17, "Rice is unimportant," but on page 12 he had already stated, "In years of plenty the production of rice is sufficient to feed the local population for about six months out of the year."

One of the valuable features of the book is its appraisal of China's historical population data. Dr. Chen believes that Chinese population has had a cyclical development and that the present cycle "has now perhaps reached its climax." He considers the round figure of 400,000,000 in 1933 as the most accurate estimate possible for recent years.

In the study of China's population one of the critical points is future growth. Dr. Chen states that, "according to general opinion, Chinese population has not shown any significant increase since 1850." He does not support this important conclusion by any firm evidence, but his earlier "Population Problems" (2nd imp., Shanghai, 1934; in Chinese), cited in a footnote, may have provided substantiation. If China's population has remained relatively static for the last hundred years, then the country may be on the threshold of a new cycle with an enormous population growth. As Warren S. Thompson points out in his book reviewed here, "we must face the fact that China will almost certainly grow by 40–60 million in each decade as soon as a few relatively simple economic and political changes are made." If this explosion takes place, the same situation will develop in China that has already developed in India, where the population increased from 353 million persons in 1931 to 389 million in 1941. This same acceleration of population growth has taken place, or is on the verge of doing so, in other areas of Eastern Asia. Irene B. Taeuber has summarized the facts in a well-documented article, "Migration and the Population Potential of Monsoon Asia" (*Milbank Memorial Fund Quart.*, Vol. 25, 1947, pp. 21–43). Individual studies of the areas have been made by Dr. Taeuber, Kingsley Davis, and others in articles appearing in recent years in *Population Index*.

It is with this problem of population explosion in the Orient that Dr. Thompson grapples in his book. Persons interested in geography will like his approach to the complex subject. After an introduction, he takes up the individual countries bordering the western Pacific; he concludes with a brief statement on migration and the importance of population pressure for peace or war and a moving argument for American interest in this international danger area. His book is written in a simple, personal style and differs from many demographic works in having few tables. There is an excellent bibliography of 502 titles, almost exclusively in English. The book is a forceful exposition of a critical situation by a well-informed demographer.—SHANNON McCUNE

LA FRANCE. Part 2, France économique et humaine, Vol. 1. By ALBERT DEMANGEON. 459 pp.; maps, diagrs., ills., bibliogrs. (Géographie Universelle, Vol. 6, Part 2.) Librairie Armand Colin, Paris, 1946. $11\frac{1}{4} \times 7\frac{3}{4}$ inches.

Shortly before his death in 1940, Albert Demangeon, who had taught economic and human geography at the Sorbonne for 30 years, handed over to the publisher the manuscript of an "Economic and Human Geography of France," the first half of which appears in this volume. When completed, this monumental work together with Professor de Martonne's "France physique" (see the *Geogr. Rev.*, Vol. 37, 1947, pp. 340–342) will present a new "tableau géographique" of France to succeed the standard work by Vidal de la Blache published in 1903.

Demangeon's contribution has a special historical value. The social structure and economy

of France have been shattered by the recent war and its aftermath; reconstruction will need to effect many changes to adapt the country to the world now in the making. Demangeon gives us with minute detail and high authoritativeness a full picture of what France was on the eve of the war and of the mutation that was to come. His work marks a stage, and it brings invaluable help to the planning of the future. But Demangeon's "France" is not only a great historical document and a geographical masterpiece. It sums up the thinking of the founder and leader of a school in human and economic geography of far-reaching influence—it is a geographical landmark.

This first volume is concerned mostly with agricultural and rural geography; industrial and urban life are left for the second volume. But the main developments in rural life (pp. 73–390) are preceded by a section on the personality of France and her role in the world and are followed by a section on the geography of transportation. This separation at times seems artificial. In this reviewer's opinion, the plan of the volume reflects the doubt that was creeping into Demangeon's mind regarding the value of the classical division of economic geography into the three branches agriculture, industry, and transportation. Here appears the fundamental conflict of the geographical method: a country is a piece of land, a territory; it stems from the soil, and to understand and describe it we must start from the soil. But a country is a country only so far as it is an individual human community, the significance of which is determined by its relation to the rest of the earth's surface; and this may be understood only through a full description of all the links—means of transportation and communication, past and present migrations and traffic, cultural contacts, capital investments and political connections. Whether to give more weight to the local element or to the outside links remained a problem for Demangeon. He inclined toward a greater emphasis on the external influences: after a country has passed beyond the initial primitive stage of the struggle for survival, it lives for the environing world and not for its own soil.

This belief pervades the introduction and Chapter 1 (Les contacts de civilisation). After having stressed the fundamental influence of nature on the nation, Demangeon shows how man's activities have achieved emancipation from this influence. "Les indications de la nature ne sont pas toujours des lois et . . . l'homme est capable de renverser les valeurs. Durant la fin du XIX^e^ siècle, on a vu s'accomplir partout des inversions économiques, les qualités des sols se changer en défauts et leurs défauts se tourner en qualités" (p. 7). And coming to the definition of a country's civilization, he says: "Une nation porte en elle, comme chaque individu, un tempérament, une mentalité, des habitudes de travail, des conceptions sociales qui sont le fruit de son évolution séculaire" (p. 11). But the dynamism of a country constantly gains momentum from its contacts with its neighbors, and France is certainly one of Europe's least isolated, least closed countries.

The population of a country is the foundation of its national life. Demangeon studies the distribution of the French population, its variations, its remarkable stability in the prosperous periods of the past—within the present boundaries, 23 to 24 millions in 1328 and the same number about 1700 (Vauban)—then the low birth rate of the recent past, the migrations, and the important contribution of immigration. A remarkable summary on foreign trade and colonial interests (Chapter 3) concludes: "Sans relations universelles, il ne resterait au travail national qu'un champ rétréci; il faut à un pays qui veut vivre d'une manière complète les grandes routes maritimes et des horizons largement ouverts sur le monde" (p. 64). Chapter 4, a short one, tells about the airways, the wire and the wireless networks. One has to jump to the concluding chapters to find a description—extremely well documented—of the other

means of communication. Ports and the maritime life are not here, however, being treated in the second volume. The last words in Chapter 21, "Circulation et civilisation," affirm Demangeon's belief that "la circulation modèle les états de civilisation; elle fait cesser les isolements, secoue les immobilités et déflore les originalités locales; elle nivèle les modes de vie et allège les conditions du travail" (p. 450). One wonders whether it would not have been more consistent to put "circulation" before the analysis of rural life.

The two sections on rural France are a whole book in themselves, and a most delightful one. The first section (Chapters 5 to 9) traces the "slow and stubborn conquest" of the soil; the second (Chapters 10 to 17) is a breakdown into "the great agricultural regions." Description of the landscapes and analysis of the economic systems are artistically interwoven. It is evident that rural problems were Demangeon's favorite geographical topic.

The lengthy epic of soil use and reclamation is told methodically: the struggle against the forest, the struggle against the waters, the conquest of wasteland, reclamation and crop rotations, fertilization, drainage and irrigation, mechanization, introduction of new crops and seed selection. An entire chapter is devoted to forestry. The distribution of ownership and tenancy is the main social aspect of rural geography, and it leads to the study of the farmstead, the biological cell of the tissue that is a cultivated area. This chapter is certainly the best summary now available in print on the agrarian structure of France. The nucleus of the farmstead is the farm itself; i.e. the buildings. "L'habitation rurale," one of Demangeon's great contributions to human geography, is treated in detail. He gives here his final classification of the types of farms: the unit plan (*maison-bloc*) and its variations; the yard house, with open or closed yard; and the elementary house, associated with archaic, disappearing, modes of life. Next he discusses the distribution of the "rural habitat." Mathematical formulae help define "scattered" and "agglomerated" habitats. The types or patterns of habitat distribution turn out to be indicative of the age of occupation of the land, reminiscent of Latin or Germanic influence, of the crop and tenancy system, of the importance of livestock in the local economy. These two chapters reveal the highest geographical acumen.

How these several elements together work out the regional pattern appears in the section on the agricultural regions. The country is divided into eight main regions: the western grasslands; the open, intensively cultivated lands of the north and the Paris area; the more diversified and compartmented east; the west center, where grains predominate among large areas devoted to grass and woods; the Central Massif, dominated by animal economy; the Aquitanian basin, where variety rules; the Mediterranean southeast, with its sunshine, its dry heat in summer, and its scattering of rich gardens; finally, the high mountain ranges, Alps and Pyrenees, with their altitudinal zoning. Throughout this descriptive section man's endeavors to shape the environment in his own way are constantly felt, and the decisive part played by transportation and markets.

It is hard to describe the perfection of Demangeon's writing. Few scholars have achieved such clarity without sacrifice of accuracy. The publishers have succeeded, in spite of the difficulties and deficiencies of the time, in keeping up the high standards of the series. Most of the photographs are excellent, and the abundant cartographic illustration is an atlas in itself. Demangeon wanted to make of his "Economic and Human France" an original work, which would not merely sum up the numerous and, in many cases, excellent regional monographs on the country. He achieved his aim. His book condenses immense knowledge and opens up new horizons. Its readers will look forward eagerly to the second half of this crowning work.—JEAN GOTTMANN

LA ROUTE FRANÇAISE: SON HISTOIRE, SA FONCTION: Étude de géographie humaine. By HENRI CAVAILLÈS. 399 pp.; maps. Librairie Armand Colin, Paris, 1946. 370 fr. 9 x 5½ inches.

This book tells the story of the growth of the highway net in France. In the background are prehistoric trails, early Gallic roads, Roman roads, and roads followed by religious pilgrims during the Middle Ages. The direct origin of the modern highways, however, is placed toward the end of the fifteenth century, when Louis XI created "les postes royales," a system of relay stations along routes traveled by royal messengers. With the creation of the *postes*, the road became a principal agent in political unification and in military action. From this beginning, there was progressive adaptation to the changing needs of the country's economic life. Integration with waterways developed at an early stage; that with the railroads is very recent. Together, the roads, the waterways, and the railroads now form a unified system unique among the transportation nets of the world.

Professor Cavaillès suggests the early antecedents in a brief introductory chapter. The body of the book is divided into three parts. The first is a detailed treatment of highway development from the end of the fifteenth century to the end of the eighteenth. The gradual change from a narrowly conceived system of *postes* maintained solely for the service of the monarch to the broad concept of a unified transport net is portrayed with great skill. An account is included of the creation of a national highway service and of the men who were instrumental in forwarding that service's growth. Problems of highway construction and maintenance are effectively discussed. The second part examines the highways in the stage-coach period, the latter part of the eighteenth century and the early part of the nineteenth. Heavier travel and greater movement of goods created new problems of maintenance and necessitated relocation of some major routes. At the close of this period the importance of the highways decreased as railroads definitely assumed the major role in the transport of goods. The third part of the book brings the story down to 1940. This period saw the complete articulation of the road and rail networks as the automobile renewed the importance of the highways. The author concludes with a short description of the main roads of France region by region.—HENRY MADISON KENDALL

ECONOMIC DEVELOPMENT IN S.E. EUROPE, Including Poland, Czechoslovakia, Austria, Hungary, Roumania, Yugoslavia, Bulgaria and Greece. [By the Economic Research Group.] 165 pp. P E P (Political and Economic Planning) (distributed by Oxford University Press), London, 1945. 10s. 6d. 8¾ x 5½ inches.

EASTERN EUROPE BETWEEN THE WARS, 1918-1941. By HUGH SETON-WATSON. 2nd edit. xv and 445 pp.; maps, index. University Press, Cambridge, England, 1946. 21s. 9 x 5½ inches.

ECONOMIC RECONSTRUCTION IN YUGOSLAVIA: A Practical Plan for the Balkans. By GEORGE RADIN. xii and 161 pp.; maps, ill. Published for The Carnegie Endowment for International Peace by King's Crown Press, New York, 1946. $2.50. 9¼ x 6 inches.

In the last two years, for reasons both political and economic, world attention has been increasingly attracted by events in the Balkan Peninsula. As is so often the case, interpretation of current happenings has been based largely on matters political—in other words, ephemeral to a high degree—while the underlying causes and trends that help shape political attitudes have often been relegated to relative obscurity, if not altogether ignored. It is on this realm

where headlines possess a passing significance only, the field of economic and historical studies, that three recently published volumes throw considerable light.

"Economic Development in S.E. Europe" may be described as a parallel volume to the two classic studies of Southeastern Europe published by the Royal Institute of International Affairs in 1939 and 1940. In concise language this small book brings the reader up to date on nutrition, food and agriculture, industrial development, transport, marketing, and the financial aspects of economic planning. It throws into sharp relief some of the more unpleasant and unpalatable facts of life in that part of the European continent, such as the low output per unit of labor and per unit of land used: "In South-East Europe one peasant grows food sufficient for 1½ persons, whereas the proportion in Western Europe is one to four; the cereal yield per hectare is about 37 per cent of that obtained in Denmark." The study suggests the basic changes in agriculture that will have to take place before Southeastern Europe can participate in European food production on equal terms with the better-organized regions of the western part of the continent.

Rural overpopulation coupled with limited absorbing capacity of the existing industrial plant points toward industrial development along lines different from those followed in pre-World War II years. Expansion of agricultural and transformation industries (for example, leather, shoes, glassware, preserved and frozen foods) is urged as a means of providing additional employment for an excess rural population unable, as recent events have shown, to find enough arable land to earn a decent living. Deficiency in storage capacity, of both perishable and nonperishable foods and other stuffs, should be remedied, and improvements in marketing, such as commodity financing and better organization for export, are suggested to provide additional outlets for existing and potential productive capacity. These suggestions are buttressed by a set of statistical tables giving information for the period immediately preceding the outbreak of World War II. In all, "Economic Development in S.E. Europe" deserves to become an indispensable companion to the student of that problem area.

"Eastern Europe between the Wars" provides both the general reader and the student of international affairs with a highly readable, well-organized account of the recent history of the region. The author approaches the subject by giving a concise and accurate picture of the geographic background and an introduction to the past history of Eastern Europe that is useful in furnishing a historical perspective on current events. His analysis of the political history of the East European states between two world wars shows how slow and painful is the progress toward true democracy and emphasizes the presence of large blocs hostile to democratic concepts in each of these states. His discussion of the thorny problem of minorities is impartial, objective, and well informed. The chapters on "Small-Power Imperialisms" and "International Experience, 1918-41" make plain the great handicap borne by these peoples of living in the shadow of a past that was often glorious but is not be be resuscitated with the meager means of the present. They also help to explain how the states of Eastern Europe failed to heed the warning to "hang together," with the result of being conquered piecemeal by the irresistible forces of German economic, political, and military imperialism.

"Economic Reconstruction in Yugoslavia: A Practical Plan for the Balkans" supplements the other two volumes by presenting not only the general outline of such a plan but considerable documentation to show how it could be implemented. The emphasis is on agricultural reconstruction, since Yugoslavia, like most of the other East European states, is primarily agricultural. Mr. Radin discusses in detail such essentials as the dietetic require-

ments of farm families, seed improvement, location and equipment of poultry breeding and hatching stations, cattle breeding and feeding, control of insect pests, and rural health insurance and administration. Although he adheres too rigidly to standards developed in the United States, without furnishing comparable information on European experience, he deserves praise for giving us what may best be described as a field manual of rural reconstruction. Henceforth the problem of rebuilding the ruined lands of Eastern Europe should be considered not merely on the basis of general principles but in the light of concrete suggestions, illustrated by figures of approximate cost, as quoted by Mr. Radin. His book should prove a welcome aid to planner and student alike.—GEORGE KISS

MALAY FISHERMEN: THEIR PEASANT ECONOMY. By RAYMOND FIRTH. xii and 354 pp.; maps, diagrs., ills., bibliogr., index. (International Library of Sociology and Social Reconstruction.) Issued in cooperation with the Royal Institute of International Affairs and the Institute of Pacific Relations. Kegan Paul, Trench, Trubner & Co., London, 1946. 25s. $8\frac{3}{4}$ x $5\frac{1}{2}$ inches.

Professor Firth defines Oriental peasants as small-scale producers who work with simple equipment, have a simple market organization, and rely largely on what they produce for their subsistence. He takes the term "land" in the theoretical sense of the economist to apply to all primary resources, including the resources of the sea, and thus speaks of the fishermen of Malaya as peasant fishermen comparable with peasant agriculturists of the inland engaged in rice farming.

Professor Firth rightfully urges that more attention should be paid to the native fishing industry of tropical regions, heretofore neglected by scientific observers and governments despite its fundamental importance for a balanced diet and proper supply of protein. The need for research, followed by a program of action, has become most pressing as a result of the war, which drove the Japanese fishermen from the fishing grounds of Southeast Asia. Between the two World Wars Japanese fishermen supplied an ever increasing share of the fresh fish landed at such cities as Manila, Macassar, Batavia, and Singapore. They introduced new equipment and new fishing methods into this area. Whereas the Malayan, Indonesian, and Filipino peasant fishermen fish mainly in coastal waters, the Japanese commercial fishermen, working with powerboats and using parent ships equipped with ice-storage facilities, ranged far afield and fished in waters not accessible to the peasant fishermen.

Because of the disappearance of the Japanese fishermen and the deterioration of the equipment of the native fishermen, the catch landed today in Southeast Asia is much smaller than in prewar days. Even before the war it was apparent that the mass of the people of Southeast Asia needed a larger supply of fresh fish. The current scarcity of both fresh and dried fish on top of a great deficit of carbohydrates creates a serious health problem. Professor Firth pleads for collaboration between the various countries around the South China Sea and a pooling of technical and scientific resources, since the problems of the peasant fishermen are the same throughout the region. It will be of interest to note that a Southeast Asia Fisheries Conference was organized and met January 6–8, 1947, in Singapore.

Chapter 1 presents a general survey of the fishing industry of Malaya and Indonesia, its market relations and income. In Chapter 2 the author describes the fishing industry of Kelantan and Trengganu, two states on the east coast of Malaya. Chapters 3 to 9 analyze in great detail the economics of a sample fishing community on the coast of Kelantan. They describe

the internal organization of the fishing industry, its productivity, planning, ownership of equipment, management of capital, credit system, marketing organization, production, and levels of income, and the sharing of the returns.

Chapter 10 places the fisherman in the wider frame of the general peasant economy of Malaya. Sections of this chapter summarize the consumption and budget studies of Mrs. Firth (Rosemary Firth: Housekeeping among Malay Peasants, *London School of Economics Monographs on Social Anthropology No. 7,* 1943).

In the final chapter Professor Firth shows the broader implications of his studies of a comparatively small fishing community and outlines the basic problems confronting the administrator who has to concern himself with the economy of peasant fishermen. The fisherman's output is low, and his income is low—often barely enough for his subsistence and that of his dependents. From a nutritional point of view Malaya needs more fish so badly that a long-range program must be designed which will stimulate output and improve marketing arrangements. But as a social anthropologist Professor Firth is well aware of the social implications of technological changes.

Several appendixes contain a wealth of additional technical and statistical data. The book is well illustrated with excellent photographs and with graphs presenting the statistical material supporting the valuable findings of the author, whose work represents a noteworthy contribution to the study and understanding of Far Eastern peasant economies.—KARL J. PELZER

STRUGGLE ON THE VELD. By RODERICK PEATTIE. ix and 264 pp.; maps, ills., index. The Vanguard Press, New York, 1947. $3.50. 8¼ x 5½ inches.

In this book Dr. Peattie, who spent some time in South Africa during the war as head of our OWI there, presents us North Americans with a clear account of the problems confronting the Union of South Africa. The struggle is primarily between races, but it is a direct result of geographical and historical circumstance.

Although the race problems of South Africa and the United States are not comparable, Dr. Peattie brings to the South African problem a democratic and practical understanding. Segregation of the natives has long been in effect, and in some places a state bordering on feudalism exists; nevertheless, the two races are bound together economically, for the white man is absolutely dependent on native labor, and native culture has been partly replaced by that of the white man. The laborers for the gold and diamond mines and for the farms are recruited from great distances, outside the Union at times, and working for the white man is forced upon the native by a head tax of one pound a year, his only need for currency. In taking the native from his home for what seems, at times, like forced labor, the white man has at least, according to Dr. Peattie, improved his life by teaching him sanitation and giving him medical care. However, where the natives have been forced to live on designated reservations, overcrowded, with depleted soil, their level of existence is very low—a disadvantage to the white man as well as to themselves.

But the South African problem is not simply that between whites and blacks. The census divides South Africans into Bantu, Europeans (mainly British and Boers), Colored, and Asiatics, listed in decreasing order of population. Conflict and struggle exist among and within these groups. British imperialism continues to be resented by the Boers, with the result that in recent years several political parties have been formed and a complex political situation created. But throughout the book the author keeps before his reader the thought

that South Africa is still a new country and that its problems are in part the growing pains of a young nation.

In a small volume Dr. Peattie covers a great deal of ground. He writes with cool logic, but also with sympathy and understanding of the difficulties besetting a very divergent group of peoples. It is a readable and timely book in this problem-burdened world.—MARY LIGHT

OTKRYTIE KAMCHATKI I EKSPEDITSII BERINGA, 1725–1742 (The Discovery of Kamchatka and the Bering Expeditions). By L. S. BERG. 3rd edit. 379 pp.; maps, ills., bibliogr., indexes. Academy of Sciences of the U.S.S.R., Moscow and Leningrad, 1946. 30 rubles. 9 x 5¾ inches. (In Russian.)

OCHERKI PO ISTORII RUSSKIKH GEOGRAFICHESKIKH OTKRYTII (Studies in the History of Russian Geographical Discoveries). By L. S. BERG. 358 pp.; maps, ills., bibliogrs., index. (Popular Scientific Series.) Academy of Sciences of the U.S.S.R., Moscow and Leningrad, 1946. 23 rubles. 9 x 5¾ inches. (In Russian.)

We are fortunate in having received two new books by L. S. Berg, which are closely related in spirit, but which overlap somewhat in subject matter. The first, "The Discovery of Kamchatka and the Bering Expeditions," is an account of Bering's two voyages in search of the passage between Siberia and North America; it includes a considerable body of material on earlier explorations of the Soviet Far East. The "Studies in the History of Russian Geographical Discoveries" consists of a series of articles dealing with topics in the history of Russian geography, including several on the Far East. Neither book is essentially new: the "Discovery" is the third (revised) edition of a work originally published in 1924 (2nd edition, 1935), and the "Studies" is made up largely of reprints of articles that have appeared in various periodicals over the past thirty years.

In his preface to the "Studies" Berg states that there is yet no detailed history of Russian geographical science; although "in hardly any other branch of knowledge has the contribution of Russian students been as great as in geography," and although scientific studies in Russia date from the time of Peter the Great, there has been little attempt to coordinate and evaluate this work. This situation raises a problem for the contemporary student, who must synthesize considerable amounts of material only indirectly relevant to his central theme in order to place this theme in its proper setting. Thus in the "Discovery" Berg is forced to devote almost as much space to a critical examination of early sources on Siberia and the Far East, in order to place the Bering voyages in perspective, as he does to these voyages themselves. This discussion may prove tedious to the superficial reader, but it will certainly be of great interest to the student of the Russian eastward movement. Its two primary contributions are a critical analysis of the literature available before 1750 and a presentation of certain primary source material available only in the archives of the various branches of the Academy of Sciences. Berg has performed a most important service in both these fields (though one might have hoped for better reproductions of the early maps).

Whereas the "Discovery" is far more than an account of Bering's two expeditions in search of America, the "Studies" is less than a complete history of Russian geography. Berg is primarily concerned with two main themes. First, he is especially interested in the Soviet Far North and Far East. Needless to say, the "Discovery" deals almost exclusively with these regions (there are sections on the Aleutians and Alaska); but this work is complemented in the "Studies" with interesting articles on early attempts to navigate the Northern Sea Route,

on early accounts of the Far North, and so forth. Second, he discusses (in the "Studies") the lives and work of several of the great Russian geographers of the past century: Semenov-Tian-Shanski, Przhevalski, Dokuchaev, Vernadski, and Anuchin. He also includes an attempt at estimating the long-term fluctuations in the height of the Caspian Sea on the basis of early reports; this leads him to discuss the literature on the Caspian Sea beginning with Hecataeus of Miletus and Herodotus. Finally, he has several shorter articles on Russian explorations in the Pacific, in New Guinea and Japan; on the first Russian mission to England; on the lost continent of Atlantis; and so on. One may hope that his next work will be a comparable volume on Russian explorations in Central Asia; his scholarly approach and extensive knowledge of the source material, both Russian and foreign, would seem to qualify him eminently for this task.—EDWARD AMES

ANTARKTIS 1502–1944: Oppdagelser, naturforhold og suverenitetsforhold. By BJARNE AAGAARD. 308 pp.; maps, ills., bibliogr., index. *Norges Svalbard- og Ishavs-Undersøkelser Meddelelser No. 60*, Oslo, 1944. Kr. 12,00.

OPPDAGELSER I SYDISHAVET FRA MIDDELALDEREN TIL SYDPOLENS EROBRING. By BJARNE AAGAARD. 117 pp.; maps, ills., index. *Ibid., No. 62,* 1946. Kr. 5,00.

In both text and illustrations "Antarktis 1502–1944" constitutes a useful historical document. To call it Norwegian propaganda is not to cast doubt on the verity of the data and conclusions, but merely to point out that the disproportionately significant achievements of the Norse voyagers in the Far South, as they apply both to discovery and to exploitation, are presented in the best possible light.

Mr. Aagaard, who has long been a prolific writer on South Polar matters, and who presented at the Sixth Pacific Science Congress, held in California in 1939, a paper entitled "Who Discovered Antarctica?" here reviews the subject in an encyclopedic text, followed by a brief but well-chosen bibliography, a list of the 126 illustrations and 27 charts, and an index. The chapter headings denote consideration of Antarctic explorers, the history of exploration, geographic structure and relationships, climate, the circumpolar Antarctic and sub-Antarctic islands, fauna and flora, and Antarctic whaling, a section that involves the record of international misunderstanding and disagreement, of conflicting national claims, and of "annexations." As was indicated above, Norwegian operations, including events leading up to the establishment of the current status of Bouvet and Peter I Islands as Norwegian territory, receive particular emphasis.

Not least among the practical advantages of this publication are the more than 50 reproductions of likenesses of Antarctic discoverers from Bouvet, Cook, Bellingshausen, Palmer, Weddell, D'Urville, Wilkes, and Ross right up to such recent or contemporary protagonists as Wilkins, Byrd, Ellsworth, Balchen, Riiser-Larsen, Isachsen, and Gunnestad. Nor is the intermediate period neglected; in fact, for portraits of individuals connected with discovery, sealing, or whaling, this book has perhaps no match. For photographs and detailed information on whaling methods in general, Aagaard's report well supplements "Der neue deutsche Walfang" of the late Dr. Nicolaus Peters (1940).

Much attention is paid to the "Norwegian sector" of Antarctica, taken over by royal decree in 1939 and amounting to about one-third of the total area of the British claims. It will surprise most American readers to learn how many discrete sovereignties have a

finger in the Antarctic pie; for areas have been solemnly attached by the Argentine Republic, Chile, and Japan as well as by European nations that have a longer history in the field. The author also gives considerable space to nomenclatural confusion, a result of successive rediscovery and renaming of many landfalls.

For a translation of both "Antarktis 1502–1944" and the following monograph the reviewer is indebted to his secretary, Miss Constance D. Sherman.

In the second monograph Mr. Aagaard builds his history of Antarctic exploration on a conventional plan, beginning in ancient times and carrying through to the attainment of the South Pole. Useful track charts show the courses of the most important voyages, from that of Bouvet in 1739; moreover, they include many tracks that are elsewhere hard to find for ready reference, such as those of Smith (1819), Bransfield (1820), Biscoe (1831–1832), Larsen (1893–1894), and Bull (1893–1895). These are not necessarily critical, nor do they take account of later controversies. Thus Weddell's track is shown as penetrating right to the head of the sea that bears his name. The gradually diminishing "still unexplored" territory also appears on these charts. An interesting feature is the series of pictures of 27 ships that have undertaken scientific work in Antarctic seas.

The text likewise deals with relatively obscure Antarctic investigation no less than with the great expeditions under national or international auspices. We find summaries of the work of Smiley (1842), Moore (1845), Dallmann (1873), Bove (1880), the Japanese Shirase (1910), and many others. A curious aspect of the report, in view of its Norwegian origin, is the quoted criticism of Amundsen for his abrupt change from North Polar to South Polar endeavor. Amundsen's portrait serves as a frontispiece, but the account of Scott's final expedition, the longest in the volume, occupies about three times as many pages as that devoted to Amundsen. The author has also made greater use of the personal and dramatic aspects of Scott's journey than he has of any of the earlier field investigations.—R. C. MURPHY

SOCIOLOGY OF TRISTAN DA CUNHA. By PETER A. MUNCH. 331 pp.; maps, diagrs., ills., bibliogr. (Results of the Norwegian Scientific Expedition to Tristan da Cunha 1937–1938, No. 13.) Det Norske Videnskaps-Akademi, Oslo, 1945. 10 x 6½ inches.

The first comprehensive scientific investigation of the island group of Tristan da Cunha, in the South Atlantic, was undertaken in 1937–1938, when a Norwegian expedition, consisting of 13 men, spent almost four months there. Studies were made of the geology, meteorology, botany, zoology, and algae of the islands and of the sociological, medical, and dental condition of the inhabitants, and a topographical survey was carried out by A. B. Crawford, a British member of the party. The scientific results are being published in English (with one volume in Latin, on lichens) by the Norwegian Academy of Science. An engaging popular narrative by the leader, Dr. Erling Christophersen (now president of the Norwegian Geographical Society), and other participants in the expedition appeared in an English translation in 1940 ("Tristan da Cunha: The Lonely Isle," London, etc.).

The area of the island of Tristan da Cunha, the largest, and the only inhabited one of the group, is scarcely three-fifths that of Staten Island, New York. Crawford's map shows the altitude of the central volcanic cone as 6760 feet, considerably lower than earlier estimates (8000 feet is given in the *Statesman's Year-Book* for 1946). The vegetation consists primarily of bog fern, tussock grass, and stunted evergreens (*Phylica arborea*). The long, low cottages of the settlement, oriented east and west with the prevailing westerly winds, toward which

they present a blank gable end, are reminiscent of the Shetlands. Both vegetation and animal life have been greatly depleted as a result of human occupation. The decline of trading contacts with the outside world has forced the islanders increasingly to exploit the local resources, with devastating results. Until about 1885 Tristan was visited fairly often—35 ships called there in 1851. From 1911 to 1937, however, in no year did more than 11 vessels make their appearance off the open landing beach, and the annual number was normally less than five; for two years (1921 and 1924) no visits are recorded. After whales, seals, and sea elephants had disappeared from the shores and near-by waters, and after steam had caused shipping to take routes that no longer approached close to Tristan, the isolation of the little community grew more and more pronounced and was accompanied by a progressive lowering of the standard of living. It is a serious question today whether the community (188 in 1938, about 224 in 1945) can continue to maintain itself (see Norman Howell: Orphan Island, *Libertas*, Vol. 5, No. 10, Johannesburg, 1945, pp. 50-59 and 75-77).

The present population consists of descendants of eight white men (three Britishers, two Americans, one Dutchman, two Italians), two English-Irish women, and five "coloured" women (four from St. Helena and a "Cape Creole") who settled on the island at various times between 1816 and 1908. In spite of inbreeding, Munch found "no signs of degeneration, either physical or mental" (see, however, Howell, *op. cit.*).

Tristan da Cunha is a paradise for those interested in the effects of isolation and of the physical environment on a culture—in this case a culture strongly British in character. Munch cautions against drawing far-reaching generalizations from conditions there but comments on the singular opportunity that the island affords for study of the growth of a community "from the very base of its foundation under a 'minimum of influence from other social systems" and of its "social forms and institutions under 'laboratory conditions', so to say, with the number of unknown factors influencing the course of the development reduced to a minimum."

The material culture of the islanders is extremely plain and primitive. They subsist in the main on potatoes and fish. Wool is spun on simple spinning wheels and knitted into garments; weaving is not practiced. Oxcarts are used on land, but boats, in the building of which skill and a distinctive style have been developed, are the primary means of transportation. Blissful ignorance of internal-combustion engines would seem to prevail. At least Dr. Munch does not mention their use. "On the whole, . . . the Tristan islanders make a curious old-fashioned impression on European visitors, and in many respects we may really regard the Tristan community as a kind of relic of the days of the clippers."

The most outstanding group characteristics are conventionality, conservatism, and a pacific disposition. Institutional organization is almost completely lacking. The social life of the community is ruled by a "spontaneous order, developed through a slow process of adjustment and enforced without the agency of any controlling organs." Behavior is regulated by public opinion and a desire to maintain personal prestige—not by laws and police. "Every islander is perfectly well aware of the fact that in all his doings and sayings he is under the Argus-eyed vigilance of the community." The standards of morality are high, and the people, though extremely individualistic, are considerate of one another and hospitable toward outsiders. Occasionally, however, as in other small, isolated communities (Munch cites Angmagssalik on the East Coast of Greenland and the Pitcairn and Andaman islanders), repression gives way to "epidemics" of hysteria, particularly among the women. The people of Tristan da Cunha are ingrained pacifists. Since "there is no other definite

group that closes on them," they have never developed any strong "consciousness of kind" and its concomitant hostility or antagonism toward others.

[Since this review was set up in type the Society has received the complete results of the expedition, published in two volumes, 1946.]

ZUR GEOGRAPHIE DES MAISBAUS: Ursprung, Verbreitung, heutige Ausdehnung des Maisbaus und seine Bedeutung für den Welthandel; Anforderungen des Maises an das Klima, mit besonderem Hinblick auf Rumänien. By JOHANNES HUMLUM. 317 pp.; maps, diagrs., ills., bibliogr. (Foreningen til Unge Handelsmænds Uddannelse, Handelshøjskolen i København, Skriftrække A, I.) Einar Harcks Forlag, Copenhagen, 1942. 10¼ x 8¼ inches.

THE ORIGIN OF MAIZE CULTIVATION. By KAJ BIRKET-SMITH. 59 pp.; map, bibliogr. *Kgl. Danske Videnskab. Selsk. Hist.-Filolog. Meddelelser*, Vol. 29, No. 3, Copenhagen, 1943.

As the subtitle indicates, "Zur Geographie des Maisbaus" divides into two main parts. The first, largely a compilation, deals primarily with the present extent and importance of maize in the world. The second part, which is the result of original research, deals primarily with the relation of Rumanian maize yields to climate.

The thoroughness of the work is evidenced by the extent of the introductory chapters. A chapter devoted to the varieties of maize known takes up each of the main groups. The origin of maize cultivation is discussed (Mangelsdorf and Reeves are closely followed), and its diffusion over the world is outlined. Although Humlum's review is a useful condensation, most of this material is more readily available in American sources. Americanists will want to consult the work which has appeared since Humlum's book was published and which modifies still further our ideas on the origin of maize and on the development and classification of maize varieties.

The chapter on the distribution of maize growing gives a detailed picture. The material is assembled by political units. For each country, as far as possible, Humlum gives maize acreage, harvest in tons, a dot map of distribution, planting and harvest times, the place of maize in the total economy and in the grain economy, and the methods of cultivation. Interculture, rotation, use for food, and other problems are discussed. Wherever data were available, a table is presented showing the yearly acreages and yields of maize in the period of about 1915 to 1940 and including the other important grains of the country.

It is difficult to summarize such a body of data. Perhaps the most significant fact is that in the period between the wars (1924–1928 compared with 1934–1938) maize cultivation increased in most parts of the world. The United States and Mexico were among the few countries showing a serious decline. In Europe growth was such that its production now equals that of all South America. Cartographic presentation of the data is complete and clear.

Statistics for export and import by countries are presented in a chapter on the maize trade of the world; the accompanying world maps of maize production and trade illustrate the lack of correlation between volume of production and volume of export. Brief summaries of the material (perhaps more easily available in American sources) on insect pests and diseases of maize and soil requirements end this part of the work.

The investigation of maize and climate in Rumania occupies somewhat less than half the book. It is introduced by a general consideration of maize and its climatic needs—Humlum's

findings indicate that weather is the dominant factor influencing annual variations in yield—and by a review of other studies of maize yields in relation to climatic elements. Here several American researchers play prominent roles, among them Wallace, Kincer, Mattice, J. K. Rose, and Visher. Consideration of the approaches used by these men establishes possible approaches for comparable studies of Rumanian corn yields. However, since the climatic data for Rumania are less detailed than for America, Humlum was somewhat restricted in what he could work out.

Precipitation, mean temperature, and theoretically possible monthly sunshine were the only factors for which Humlum had sufficiently long-term data. The period April to October, which includes the growing season for maize in Rumania, is used. The material is arranged by provinces, exclusive only of 22 mountain provinces that grow very little maize and have too few weather stations. Records for precipitation came from 300 weather stations distributed over the 49 provinces that produce 90 per cent of Rumania's maize. For mean temperature, records were available for 70 stations in 36 provinces, but for sunshine, only 12 provinces with two stations in each province provided data. Humlum notes that the use of these three factors does not give a linear correlation with maize yields but that the approach is sufficiently close to indicate that these are the major causes of variation in Rumania's maize harvest.

Rainfall correlations are calculated for each month, and the correlation distributions shown. This method brings out clearly the variation in rainfall and its differing effects in the divergent climatic regions of Rumania. For example, correlation of May rainfall ranges from +.60 in one province to -.60 in another; July, however, shows no area with a negative correlation—the more rain the better. Temperature and sunshine show similarly varying correlations from month to month and region to region. A few generalizations follow. In May, June, and July, eastern Rumania receives too little rain; westward, summer rainfall becomes progressively less critical; only in the mountains is the temperature unfavorably low in all months; May, in general, is too cool for optimum corn growth, except in Bessarabia, where the temperature is nearly ideal in spring and early summer; July, August, and September, especially in Walachia and Dobruja, are too hot; sunshine generally shows a positive correlation, except, at times, in parts of Moldavia and Bessarabia (boundaries are pre-World War II).

A comparison of variations of wheat yields with those of maize is included to demonstrate the fallacy of the often repeated statement that wheat and corn yields are in inverse proportion. On the contrary, a good corn year is generally a good wheat year. The final chapter sums up deduced climatic optima for maize cultivation in Rumania, with comparisons with the other principal maize-producing lands.

This is an outstanding work. It is of value not only for its assembling and marshaling of a vast amount of useful information on maize but also for its demonstration of an economic geographer's approach. Those acquainted with other monographic studies of corn, mostly agronomic in interest, will recognize the importance of this. The wealth of maps greatly facilitate the presentation of the material. In his cartographic presentation Humlum again displays his geographic competence.

American work on the origin of maize and its related problem the origin of agriculture led Birket-Smith to try a new solution. In "The Origin of Maize Cultivation" he turns primarily to a linguistic analysis of the terms used for maize by the tribes of South America. The results are interesting both in themselves and for the method used.

The botanical situation is described: maize is a plant of innumerable varieties (more than

8000), so modified from its wild form that it is no longer able to propagate itself, and so different from other plants that it has been placed in a genus by itself. The only closely related genera are *Euchlaena* (*teocentli*) of Mexico and Guatemala and *Tripsacum*, or gama grass, fairly widespread in America.

The theories of other investigators are briefly reviewed. The author carefully goes back to original sources and quotes key statements verbatim. Thus critical sections of Saint-Hilaire's remarks on pod corn from South America are quoted to correct erroneous ideas that have arisen concerning statements made by this nineteenth-century botanist. De Candolle's hypothesis of the Colombian home of maize and Harshberger's postulation of Mexican *Zea canina* and, later, *Euchlaena*, as its "progenitor," Kempton's statement that the greatest number of varieties of maize are to be found in Peru and Yuzepchuk's belief that maize was introduced into Peru from Paraguay or Brazil, are all noted. Archeological evidence on cultural primacy and contacts and Spinden's, Gladwin's, and Sauer's considerations of the origins of agriculture are briefly presented with critical comments. This review of previous theories is of considerable value and interest. The author follows Mangelsdorf and Reeves in seeking a South American origin for maize, but he finds many ethnological reasons for not accepting the Gran Chaco as its probable home. Consequently, he states, "we are confronted with the alternative of choosing between the Andean regions and the Amazon area." Since there is very little detailed information on the corn types cultivated by the Indians of the Amazon Basin, Birket-Smith utilizes the linguistic material available to him. Of this he has a good supply; for example, he has assembled the words for corn from more than sixty tribes of the Arawakan stock alone. Analysis for linguistic relationship ultimately reduces the multiplicity of terms to a few basic stems: one Tupian, one Cariban, three or four Arawakan, one Tucanoan, and one possibly Jivaran.

When Birket-Smith carries his analysis to the Andean region, he finds linguistic relationships which he thinks indicate that knowledge of maize moved from the Andes to the adjacent parts of the Amazon Basin. He finds two major Andean centers: a Peruvian center, with extensions into the adjacent lowland; and a Colombian center, of enormous extent (northern Peru to southern Mexico and including most of the Amazon Basin). This linguistic evidence suggests that Colombia is the home of maize. In corroboration Birket-Smith points to the favorable physical environment for maize, particularly in the Magdalena Valley, and to the Russians' emphasis on Colombia as a primary center of domestication (arracacha, two primitive potatoes, quinoa, perhaps manioc). He notes that there is much evidence that Colombia has been important as a cultural center in South America as far back as our archeological knowledge reaches, whereas to the north and south there are indications of a relatively late and sudden appearance of agriculture, including maize cultivation.

Several points are open to question. Some will not agree with the assumption, to which Birket-Smith tends to hold, that American agriculture had a single origin. It is also difficult to accept his final conclusion that agriculture in Colombia, which he believes to be the oldest, is not much earlier than 2000 B.C. Maize is a botanical fact, not a "cultural element" (p. 10), and ethnological findings concerning culture traits are not necessarily valid in botany. The dismissal of Ulrich Schmidel's early observation that the Guaycuru, or whatever tribe he was referring to, "hatt grosse profannt" of crops on the basis that the Guaycuru couldn't have had much agriculture or they would not have so readily abandoned it does not agree with the history of the abandonment of agriculture by the prairie tribes of the United States when they, like the Argentine people, took up "horse culture." The author uses the Russian

plant geographers' thesis that Colombia is a center of origin of American agriculture, but he disregards their belief in plural origins of agriculture. Many will regret the almost complete lack of maps—only one small-scale map of the distribution of maize words is included. A tribal map, and also more detailed maps of linguistic distributions, would have been particularly helpful.

But these are minor flaws in an excellent paper whose chief fault is brevity. Birket-Smith has made a distinct contribution by assembling and analyzing the linguistic data and drawing attention to the broad groupings of maize words and their geographical distribution. His conclusion that Colombia is the center of origin of maize cultivation is worth careful consideration.—GEORGE F. CARTER

MEASUREMENT OF GEOGRAPHIC AREA: Sixteenth Census of the United States: 1940. By MALCOLM J. PROUDFOOT. v and 120 pp.; maps, diagrs., ills., index. Bureau of the Census, U. S. Department of Commerce, 1947. $1.50. 11¾ x 9¼ inches.

Since the time of the first census (1790) of the United States, if not, indeed, earlier, there has been a growing awareness of the need for an accurate measurement of geographic areas. The United States Bureau of the Census in particular has felt this need with the increase in the degree of detail and the scope of its census enumerations and their cartographic presentation as well as in the evaluation of results for the purpose of comparative study. Dr. Malcolm J. Proudfoot, formerly assistant geographer of the Bureau of the Census, has contributed a useful and scholarly study of the "Measurement of Geographic Area," particularly in the United States.

Although the core of the study is concerned primarily with the development of a suitable method for the measurement of geographic area for the census of 1940, a substantial part of the text is devoted to a historical summary of the "development of techniques and tools required for the measurement of geographic area and to . . . [a discussion of] the work of those men who have contributed to this development." This has increased the value of the study immeasurably, as have the appendixes (pp. 55–117), which are for the most part facsimile reproductions and reprints of publications documenting the "development of geographic area measurement, particularly in the United States." The historical summaries comprise "Geodesy, Cartography, and Area," "Ancient and Medieval Areas," "Developments in Area Measurement," "A Solution for the Problem of Area Measurement," "Modern European Areas," "Developments in the United States" (pp. 3–29).

This reviewer was surprised to note that the author has included the table of "Areas, Families, and Dwellings, with the Distribution of Population to Each, in the United States" from the "Statistics of the Population of the United States . . . from the Original Returns of the Ninth Census, (June 1, 1870)" rather than the more comprehensive and useful table "Area, Population, and Average Density of Settlement of Each State or Territory at Each Census [1790–1870]," and particularly "Areas and Political Divisions of the United States 1776–1874 [with map and tables]," both in Part II of the "Statistical Atlas of the United States Based on the Results of the Ninth Census 1870" (F. A. Walker, compiler, 1874; in three parts).

Chapter 8, "Remeasurement of the United States: 1940" is a statement of the criteria employed in the selection, evaluation, and ultimate measurement of the large- and small-scale official (United States and local government) maps and cadastral surveys available for settlements, minor civil divisions, and larger political units of the United States, and, particularly,

a discussion of "the knottiest problem, [which] was that of setting outer limits for the United States," as presented cartographically on pages 38–51. The results of these measurements of minor civil divisions and the remeasurement of counties and states are published in the comprehensive work prepared under the supervision of Clarence E. Batschelet and Malcolm J. Proudfoot "Areas of the United States: 1940" (Sixteenth Census of the United States, Bureau of the Census, 1942). The author recognizes the influence that the work of his associate in the 1940 report, the Geographer of the Census and his former chief, has exerted on the present publication. He also gives credit to the two basic works by W. Schmiedeberg and T. Willers on the history of areal measurement respectively before and after the invention of the planimeter.

"Measurement of Geographic Area" is well documented and reveals the author's scholarship and mastery of basic foreign-language sources. Illustrations and facsimile reproductions contribute to the professional usefulness of this study.—HERMAN R. FRIIS

AIRPORTS OF TOMORROW: Report of the Regional Airport Conference on Its Plan for Development of an Airport System for the New York Metropolitan Region. 47 and 19 pp.; maps, diagrs., ills. Regional Plan Association, New York, 1947. 11¼ x 8½ inches.

In this volume the Regional Plan Association presents a comprehensive plan for an integrated system of airports capable of handling the growing air commerce of the New York–New Jersey–Connecticut Metropolitan Area. This plan, involving 4 major transport landing fields, 8 supplementary major airports, 18 secondary airports, and 99 local airports (of which a small number are already in operation), has received the formal approval of the Civil Aeronautics Administration, as basis for the formulation of the National Airport Plan for the New York City Metropolitan Region.

A considerable amount of factual material is contained in this report, most of it in the form of graphs, tables, and maps. One of the graphs is made the basis for establishing airport requirements of the future, from estimated peak-hour plane movements during the 15-year period ending with 1960. Starting from 53 plane movements (peak) in 1946, the curve climbs rapidly to 238 movements in 1952, then rises less sharply to 296 movements in 1957. From this point it flattens out considerably to an estimated 302 movements in 1960—an indication that any solution proposed for handling the traffic increases of the next decade should serve for the entire predictable future as well. The same graph shows how facilities at La Guardia and Newark Airports, with 40 plane movements an hour each, are already insufficient, and that even when Idlewild Airport, with its 40 additional movements, is completed, the three together will barely meet 1948 requirements. The immediate solution propounded is to expand Newark and Idlewild from single-runway to dual-runway airports, on the reasonable assumption that separate runways for incoming and outgoing traffic should about triple the facilities of a single runway. The resulting theoretical aggregate capacity of 280 movements per peak hour, it is considered, would be sufficient until the end of 1955. Beyond this, a fourth major airport, perhaps in the Hackensack Meadows area, would fill further needs for passengers, mail, and express.

Air freight, in spite of the enormous increases expected, is considered from a standpoint apart; for plane passenger traffic, by virtue of its higher ton-mile income, would earn preference during peak-hour periods at terminal airports. The plan suggests separate freight ports eventually, with special cargo handling facilities.

An important point which this volume clearly establishes is that it is out of date to consider state, county, and municipal boundary lines in the air age; "an adequate airport plan must take into consideration the geographic and economic factors of an area rather than its political unity."—WILLIAM E. RUDOLPH

THOMAS JEFFERSON, AMERICAN TOURIST: Being an Account of His Journeys in the United States of America, England, France, Italy, the Low Countries, and Germany. By EDWARD DUMBAULD. xv and 266 pp.; ills., bibliogr., index. [American Exploration and Travel Series.] University of Oklahoma Press, Norman, 1946. $3.00. 9¼ x 6 inches.

Jefferson was a purposeful traveler if not a wide-ranging one. He rarely indulged in needless jaunts and junkets but traveled where his duties required and, while in Europe, sought experiences that would be beneficial to his country. These traits are exemplified by his most extensive European tour, undertaken in the early months of 1787. Advised by Paris physicians to journey to southern France, Jefferson was the readier to comply because en route he could carry out a long-held wish to visit Bordeaux and other seaports. Later, at Dijon, he minutely recorded the steps in wine making; manufactures and the arts drew his attention at Lyons; across the Alps in Italy he became interested, among other things, in a species of rice whose exportation was prohibited. Nevertheless, he wrote a friend: "I have taken measures . . . for obtaining a quantity of it which I think will not fail & I bought on the spot a small parcel which I have with me."

In addition to his travels in half a dozen European countries and the seaboard states, Jefferson participated in the plans and experiences of other travelers, showing that in this activity, as well as in science and art, he was both promoter and practitioner. Chapter 7, "Charged like a Bee with Honey," is given over to Jefferson the vicarious traveler.

This book, edited and bound in the tasteful style of the "American Exploration and Travel Series," is of chief interest to antiquarians and to specialists in certain phases of American history and biography. To the general reader, hoping perhaps from the title to meet a new, globe-trotting Jefferson cut loose from the dignities and confining duties of high office, the book will be less rewarding. Jefferson the traveler remained strictly in character. By his own writings he did little to enrich travel literature, though copious notes were prepared for others to work with—and over. The author has done well to give coherency to so many fragmentary and scattered records.—RALPH H. BROWN

TRIEST: Seine Entwicklung und seine Funktion als Hafen. By JOSEF MATZNETTER. Maps, bibliogr. *Mitt. Geogr. Gesell. Wien*, Vol. 89, 1946, pp. 11–34.

This article, received just as the October number of the *Geographical Review* goes to press, makes an interesting comparison with Leonard Unger's "The Economy of the Free Territory of Trieste" (pp. 583–608). In facts and views the two are in general agreement, and Dr. Matznetter's maps of volume of export and import trade constitute a useful supplement

A

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ERRATA

p. 76. Transpose captions to Figures 6 and 7.
pp. 205 and 212, Figs. 2, 3, and 4. For correct location of Callao (G) see Figure 1.
p. 212. Fig. 3. Delete false department boundary across Lucanas Province (E–5); see Figure 1. San Martín Province (U–6) and Cajatambo Province (O–2) should be shaded (32.5 per cent and 91.1 per cent, respectively).

ADDITIONAL ERRATUM FOR VOLUME XXXV

p. 626, line 15, *for* weighed *read* weighted.

ADDITIONAL ERRATUM FOR VOLUME XXXVI

p. 446, lines 6 and 7 from bottom. Delete "Graphic . . . moment."